ASTM BULLETIN

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"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

TELEPHONE—PENnypacker 3545 CABLE ADDRESS—TESTING

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1938 Annual Meeting Atlantic City, June 27 to July 1

Impact Symposium Important Technical Feature

In addition to the Symposium on Impact Testing, an important technical feature of the 1938 (Forty-first) Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, June 27 to July 1, inclusive, Committee E-6 on Papers and Publications is developing a well-diversified program, based upon the large number of offers of papers submitted to it.

In addition to the papers there are several very important committee reports being developed which will add to the interest of the meeting.

In going back to Atlantic City after the outstanding meeting held in New York City in 1937, the Society returns to a location which appeals to a great many of the members and where many successful meetings have been held in the past. There will be no exhibit of testing apparatus during 1938, in line with the Society's policy thus far of holding exhibits only at two-year intervals.

IMPACT SYMPOSIUM

Considerable progress has been made in developing the symposium on the subject of impact failure and impact testing and it promises to be a most interesting feature of the meeting. A previous symposium on this subject was held by the Society in 1922.

Increases in the normal speeds of machines and vehicles, insistent demands for reduction in unnecessary weight in the use of materials have in the intervening years made the subject of increasing importance. The development of the use of welding with its consequent discontinuity of microstructure in metals and differences in thermal treatments has initiated new and important studies of impact properties and tests. Much work has been done on the subject and numerous papers published. Differences of opinion on impact have remained strong and varied and the fundamental theory of failure has not yet been clarified.

The symposium will be an effort to present an integrated series of papers covering the basic theories underlying impact tests, data on the factors affecting impact, and papers covering the practical application of impact tests to metals, organic plastics and welds. The symposium is prompted by the extraordinary interest in the round-table discussion held at the last annual meeting by the impact section of Committee E-1 on Methods of Testing in cooperation with those interested in welding as represented by the A.S.M.E. and American Welding Society. In that discussion it was clearly developed that the impact problem consists of three related effects, (1) shape or notch effects, (2) velocity effects, (3) temperature effects. The symposium will contain papers treating each effect from the standpoint of homogeneous materials and also for welds and a discussion of the basic theory underlying all three. In addition papers will be presented on the practical application and utility of impact testing in the prevention of failures in use.

Some of the questions which it is expected the symposium will clear up or at least give partial answers to are the following: What is the purpose of an impact test? Does it measure notch sensitivity, or velocity sensitivity, or some

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other property of the material? To what extent have impact tests been successful in commercial practice in weeding out unsatisfactory material? While much of the work done in the last few years may not enable definite answers to these questions, it is felt the symposium will be a particularly advantageous one in presenting a review of just where various problems stand. Broadly, the symposium will be an authoritative review of our present knowledge on impact failures and methods of test.

The symposium is an inter-society cooperative project. In addition to A.S.T.M., the American Welding Society through its Welding Research Committee (jointly sponsored by the American Institute of Electrical Engineers) and the American Society of Mechanical Engineers, through its Applied Mechanics Division, are co-sponsors.

OTHER FEATURES

It is expected that one session of the meeting will be devoted to papers on Water for Industrial Uses, including embrittlement testing of boiler waters, referee and field methods for determining dissolved oxygen in water, sodium in water, and intercrystalline cracking as produced by concentration of boiler waters in capillary spaces, etc.

There will be the usual groups of papers in the metals fields, including such problems as effect of temperature, fatigue, and hardness measurements. There is expected to be a group of papers covering certain problems involved in radiographic testing and other papers on specific subjects in the field of testing. Several papers involving cementitious and related materials are to be presented.

As in previous years, the Provisional Program for the meeting, giving condensed synopses of technical papers and reports, will be published in the May BULLETIN.

Detroit Meeting to Discuss Protection Against Corrosion

At a dinner meeting to be held in Detroit at the Detroit Leland Hotel on Tuesday evening, April 19, under the auspices of the Detroit District Committee, the technical feature will be a Symposium on Protection Against Corrosion. The chairman of the District Committee, W. H. Graves, Chief Metallurgist, Packard Motor Car Co., will preside. Four short papers have been obtained by the Program Committee under the chairmanship of T. A. Boyd, Head, Fuel Dept., Research Laboratories Division, General Motors Corp. These papers are as follows:

Corrosion-Resistant Alloys—H. W. Gillett, Metallurgist, Battelle Memorial Institute.

Plating—C. E. Heussner, Materials Engineer, Chrysler Corp.

Pretreating Metals—Ralph Wirshing, Research Laboratories Division, General Motors Corp.

Organic Coatings—J. L. McCloud, Metallurgical Chemist, Ford Motor Co.

Opportunity will be afforded for discussion of these interesting topics.

At the dinner which is scheduled for 6:30 o'clock, President A. E. White and Secretary-Treasurer C. L. Warwick will give brief talks. The technical session follows at 8 o'clock.

All members and their friends and others interested in the subjects to be discussed are cordially invited to attend the meeting.

Important New Building Codes Use A.S.T.M. Standards

In a recent Bulletin there was an article on the use of A.S.T.M. standards in important building codes, in particular the building code for the City of New York which went into effect on January 1, 1938. Two other large cities, Chicago and Boston, are making use of a number of A.S.T.M. standards in their new codes.

Parts of the Chicago code which have been adopted up to January 1, 1938, cover title, purpose and scope; administration; arbitration, standards, registration and penalties; structural provisions; foundations; wood construction; masonry construction; reinforced concrete construction; steel and metal construction; and chimneys. In the list of A.S.T.M. standards given below referred to in the portions of the code adopted there are included also those referred to in the building regulations for reinforced concrete, the American Concrete Institute building code (A.C.I. 501 – 36 – T) which with certain exceptions covers the Chicago code requirements for design and construction of reinforced concrete.

STANDARDS REFERRED TO IN CHICAGO CODE

Steel for Buildings (A 9)
Billet-Steel Reinforcement Bars (A 15)
Rail-Steel Reinforcement Bars (A 16)
Carbon-Steel Castings (A 27)
Cast-Iron Pipe (A 44)
Gray-Iron Castings (A 48)
Cold-Drawn Wire for Concrete Reinforcement (A 82)
Common Iron Bars (A 85)
Structural Silicon Steel (A 94)
Structural Rivet Steel (A 141)
Quicklime (C 5)
Hydrated Lime (C 6)
Portland Cement (C 9)
Compression Test Specimens (C 31)
Structural Clay Tire (C 34)
Compression Tests of Concrete (C 39)
Concrete Building Brick (C 55)
Structural Clay Non-Load-Bearing Tile (C 56)
Building Brick (C 62)
Sand-Lime Building Brick (C 73)
High-Early-Strength Portland Cement (C 74)
Load-Bearing Concrete Masonry Units (C 90)
Masonry Cement (C 91)
Ready-Mixed Concrete (C 94)

Intensive work on the part of a special commission has resulted in a newly proposed building code for the City of Boston, Mass. The report of the commission embodying the building code has been submitted to the state legislative body for official action.

In various portions of this extensive code, references are made to A.S.T.M. standards.

STANDARDS REFERRED TO IN BOSTON CODE

Structural Clay Floor Tile
Structural Clay Load-Bearing Wall Tile
Gypsum Partition Tile or Block
Gypsum and Gypsum Products
Quicklime for Structural Purposes
Hydrated Lime for Structural Purposes
Portland Cement
Organic Impurities in Sands for Concrete
Billet-Steel Reinforcement Bars
Rail-Steel Reinforcement Bars
Cold-Drawn Wire for Concrete Reinforcement
Making and Storing Compression Test Specimens of Concrete in the Field
Making Compression Tests of Concrete
Calcined Gypsum
Steel for Bridges
Structural Rivet Steel
Carbon-Steel Castings
Gray Iron Castings

Since this proposed new code which can be considered one of the most modern ones does not incorporate the serial designations of the standards, they are not given in the accompanying list.

Plastics Symposium Features Regional Meeting

Interesting Program and Dinner Held

An interesting technical session on plastics and a dinner at which there was an address on "Balloon Exploration of the Upper Atmosphere" featured the 1938 A.S.T.M. Regional Meeting held at the Hotel Seneca, Rochester, N. Y., on March 9. There was an excellent attendance (450) at the session in which the symposium was held and also at the dinner in the evening.

The Symposium on Plastics was developed by a special committee consisting of the officers and subcommittee chairmen of Committee D-20 on Plastics and including L. N. Shnidman, representing the local Rochester committee. Mr. W. E. Emley, National Bureau of Standards, chairman of Committee D-20, headed the symposium committee.

The Rochester Committee on Arrangements had planned in addition to the dinner a number of features for the entertainment of members during the week, including motion picture performances on Tuesday and Thursday evenings. Subjects covered including "Modern Photography," "Eyes of Science," "Car-Retarders for Use in Classification Yards," and "The Largest Engineering Instrument." A number of inspection trips to industrial plants were arranged and numerous members took advantage of these throughout the week. Companies cooperating included the Bausch and Lomb Optical Co., Eastman Kodak Co., General Railway Signal Co., Ritter Dental Mfg. Co., Rochester Gas and Electric Corp., The Symington-Gould Corp., and the Taylor Instrument Co.

In addition to the officers listed below, many other members in the Rochester area served on the various committees which had been appointed. The committee did a most excellent job in carrying out the various arrangements for the meeting.

ROCHESTER COMMITTEE ON ARRANGEMENTS

F. R. Baxter, *Honorary Chairman*
I. C. Matthews, *Chairman*, Research Chemical Engineer, Research Laboratories, Eastman Kodak Co.
O. L. Angevine, *Secretary*, Executive Secretary, Rochester Engineering Society; also *Chairman*, Registration Committee
Louis Shnidman, Laboratory Director, Rochester Gas and Electric Corp., *Chairman*, Program Committee.
L. V. Foster, Optical Engineer, Bausch and Lomb Optical Co., *Chairman*, Entertainment and Banquet Committee
E. N. Hurlburt, Sales Engineer, Taylor Instrument Co., *Chairman*, Plant Inspection Committee
H. L. Howe, Engineer, Division of Engineering, Department of Public Works, City of Rochester, *Chairman*, Finance Committee
F. R. Scherer, Superintendent of School Buildings, Board of Education, *Chairman*, Publicity Committee

The address on "Balloon Exploration of the Upper Atmosphere" by Doctor Brian O'Brien, University of Rochester, was most interesting and a portion of it, comprising the general introduction, is published in another part of this BULLETIN.

The papers comprising the Symposium on Plastics, together with discussion, will be published in a special volume later in the year—further announcements will be made concerning this. Attention is called to the fact that those wishing to submit written discussion of any papers should send this to Society Headquarters before April 27.

SYMPOSIUM ON PLASTICS

The six papers in the Plastics Symposium were as follows:

The Properties of an Ideal Plastic—A. F. Randolph, E. I. duPont de Nemours, Inc.
A Discussion of Testing Methods for the Determination and Comparison of the Strength Properties of Various Organic Plastics—H. M. Richardson, General Electric Co., Pittsfield Works
A Review of Methods for Measuring the Thermal Properties of Plastic Materials—W. A. Zinzow, Chief Physicist, Bakelite Corp.
Flow Relations of Thermo-Plastic Materials—C. H. Penning and L. W. A. Meyer, Tennessee Eastman Corp.
Hardness—as Applied in the Plastics Industry—J. C. Pitzer, Chemist, The Formica Insulation Co.
Permanence of Plastics—Gordon M. Kline, Chief, Organic Plastics Section, National Bureau of Standards

Mr. E. K. Carver, Eastman Kodak Co., presided as chairman, with Mr. Emley as co-chairman.

A. F. Randolph pointed out that each of the commercial plastics offered a combination of merits and deficiencies which determines its field of usefulness. After giving a proposed definition of a plastic, namely, a material which contains as its essential ingredient an organic binder and which, at some stage in its manufacture or in the fabrication of articles from it, is capable of being shaped by flow while in a plastic or liquid condition, and thereafter is capable of being brought to a more or less rigid condition, he pointed out that plastics are ordinarily classified in terms of their respective base materials—cellulose acetate, phenol-formaldehyde, and so on, there being many of these. Another convenient classification is based on the behavior of the material in its final form toward heat, distinguishing between the thermoplastic, which may be repeatedly softened by heating and hardened by chilling, without undergoing permanent change in behavior, and, on the other hand, the thermosetting, which, while softened by the initial application of heat, is hardened by continued heating and is thereafter no longer capable of being appreciably softened by heat.

In outlining properties of an ideal material, low cost was indicated as most important; specific gravity should be low since the cost per volume is generally more important than the cost per pound. Ease of fabrication is important and softening temperature should be high to increase the range of utility. A low molding temperature and high strength (tensile and impact properties) including high impact strength is desirable. Compressive strength is seldom of significance, but surface hardness should be as high as possible. While the index of refraction should preferably be high, complete absence of haze is of greater importance. Moisture absorption should be low, solubility in organic solvents should be a minimum and likewise liability to chemical attack. Odor and taste should be absent. Permanence of properties under prolonged exposure to light and to high temperatures as well as with simple aging, is important, particularly in such a use as safety-glass interlayer, where, however, some protection can be given by suitable selection of glass.

In discussing testing methods for strength properties of various organic plastics, H. W. Richardson pointed out that to one not already familiar with plastics, it is difficult to choose from those available since published data on physical properties may not be on a uniform basis. Normally, the

purchaser would want to know what is going to happen if he pulls, bends, compresses, or drops the article he is going to make, and what performance will result. Usually he wants to know about the tensile and compressive strength, modulus of elasticity, also elongation and the effect of notches or holes; how well will it withstand fatigue and the effect of various flow conditions. To determine tensile strength properties, it has been suggested that photo-elastic analysis be used to determine proper shape of the tension specimen. While the modulus of elasticity may require arbitrary definition because of its variability, deflection curves will probably be necessary for ductility or plasticity characteristics. While a fatigue test might involve a repeated impact, torsion, or flexing test, the author stated that as yet no very satisfactory test of this sort had been worked out for plastics.

In reviewing methods for measuring the thermal properties of plastic materials, W. A. Zinzow pointed out that while determinations of thermal expansion for any material are relatively simple in theory, some difficulties may be encountered in practice, one of the difficulties being that shrinkage of the material at elevated temperatures may be of the same order of magnitude as the change due to expansion alone. The question of tests in this field is one on which work needs to be done. Since most plastics are used at relatively low temperatures, the emissivity does not seem important, but heat distortion or softening point is a property of considerable interest. The author indicated the possibility of an indentation or penetration type of test to cover this property. The plastic flow of material is of primary importance to all molders or plastics. Another property of importance is shrinkage, particularly if close tolerances are specified on finished pieces. Difficulties of determining mechanical properties at elevated temperatures were outlined and the need for coordinating work was stressed.

In their paper on "Flow Relations of Thermo-Plastic Materials," Messrs. Penning and Meyer pointed out that to determine flow the methods in general use involve the Olsen Bakelite flow tester, which while developed primarily for thermo-setting materials, is now being used on thermoplastic materials by various companies. The authors discussed in detail this testing instrument and its application and gave a number of results of tests in the form of tables discussing also the question of flow ranges. A proposed standard flow classification chart was presented based on the use of this flow tester. A practical method of determining flow classification of a given material was then described by the use of which five or six materials of different flow could be run at different temperatures.

J. C. Pitzer in discussing hardness, pointed out that it was of considerable commercial importance, but that any test method devised must be adaptable over a wide range since plastics may vary from very soft to very hard products. Just one hundred years after the first work on hardness was done by Mohs in 1822 the first published work on measuring the hardness of plastic materials was written by Dellinger and Preston.

There are four types of tests in this field: (a) penetration, (b) abrasion, (c) cold flow (properties of elasticity) and (d) machinability. Penetration tests can be divided into three classes where indentations are made with (a) spheres, (b) prisms or cones and (c) machines using the rebound principle. These tests have found the widest application in attempts to correlate such properties as punching, machining, buffing and mechanical wear resistance of plastics.

While the Mohs hardness scale is the best known of the abrasion type, various sclerometers such as the Bierbaum scratch resistance apparatus have been developed to give a more numerical scratch value. Scratch hardness is of considerable importance because many plastic materials are used where abrasion is an ever present possibility.

In his paper on "Permanence of Plastics," G. M. Kline stressed the fact that the designer, engineer and consumer want definite facts on the various plastics behavior under

Rochester Committee on Arrangements

Front Row, from left to right: F. R. Scherer, E. N. Hurlburt, F. R. Baxter, I. C. Matthews, L. V. Foster, Louis Shnidman, H. L. Howe; Second Row: W. T. Morgan, C. T. Wallis, N. H. Stevens, O. L. Angevine, H. E. Seemann, J. J. Desmond; Third Row: J. D. Putnam, C. F. Bullard, C. C. Nitchie, E. H. Branson, W. J. Conley, F. J. Comerford.

various service conditions and that the failure of adjectives to take the place of data obtained by recognized tests emphasizes the importance of the work of Committee D-20. He indicated that in no other group of properties is there such a need for standardization as in the permanence class. Two factors have an important bearing on permanence, namely, composition and molding conditions, both closely related to the stability of the finished product. Methods used to determine the effect of such agents as light, water and chemical reagents were reviewed. To determine the effect of light, various exposure tests have been made and a new rotating rack which keeps specimens perpendicular to the sun's rays at all periods of the day was mentioned. Data on the effects of light on a number of types of plastics were given. Other accelerated laboratory tests were mentioned, including a recent one employing a sun lamp.

The author indicated that the absorption of water by plastics either at high relative humidities or upon immersion is undesirable for many applications because of its adverse effect upon electrical properties and upon dimensional stability. Although most synthetic resins take up only 0.1 to 0.2 per cent of water, the great bulk of commercial molding compositions have fibrous fillers, such as wood flour, paper, and woven fabric, which have a pronounced affinity for moisture and are only partially protected by the resinous binder. Tests made under carbon-arc light, both with and without water spray, indicate that some plastics deteriorate more rapidly in the presence of water. The importance of conditioning environment in the testing of plastics was stressed —various tests such as strength, hardness, optical, thermal and electrical made in a definite environment will make correlation of resulting data more reliable.

Balloon Exploration of the Upper Atmosphere[1]

By Dr. Brian O'Brien[2]

The development of the modern airplane has added considerably to our knowledge of the lower atmosphere, but there are many features of the upper air beyond the airplane ceiling which, if more fully understood, would be of both scientific and practical value. Although the rocket holds promise for future explorations at high altitudes, the balloon offers at present the only practical method for lifting an instrument well into the stratosphere.

A balloon can reach about double the altitude attainable at present by any airplane and, in the case of small instrument-carrying balloons, at a cost less than that of a single high-altitude airplane flight. The vertical gradients of temperature and humidity, which are of great importance in weather forecasting, can be secured in this manner. Samples of the upper air may be brought down for analysis, and so, by the study of the distribution of certain atmospheric constituents with height, information is secured on the vertical stirring of the atmosphere.

Perhaps of even more importance, a balloon makes possible the measurement of radiations which come to the earth from outer space, and which are altered or entirely lost in the atmosphere before reaching the earth's surface. Cosmic radiation which has received so much attention in recent years is of this sort, but so also is a very commonplace kind of radiation, namely, sunlight, both visible and invisible. It is sunlight and its measurement which has led us, first, to perfect instruments and methods which can be used at the earth's surface, and more recently to the development of methods for its measurement by instruments carried on high-altitude balloons. It is the story of this part of balloon exploration of the upper air that I want to discuss.

The flood of radiant energy which comes to us from the sun, supplying heat as well as light, is of quite obvious practical importance. The earth is constantly losing heat by radiation to space, and its surface would soon drop to a temperature not far above the absolute zero were this radiation loss not continuously replaced by the energy received in the form of sunlight. But not only are our surroundings maintained at temperatures which will support life; our very food supply is dependent upon the photochemistry which sunlight works for us in all the green plant life upon the earth's surface.

We of the animal kingdom are parasites, pure and simple, and must depend directly or indirectly upon food derived from green plants which can literally create food substance from our products of combustion, using the energy of sunlight to carry out the necessary chemical reactions. Not only food but fuel is continually being formed for us in this manner. The plant life on the earth is actually "unburning" our coal and oil as rapidly as even our energetic race can burn it, taking the products of combustion, which are carbon dioxide and water vapor, and turning them back, with the aid of sunlight, into sugars, starches and cellulose ready to be burned or eaten again. The green of the plant world is due to a remarkable substance, chlorophyll, which is the touchstone by which the energy of sunlight can be made to do this work.

We receive from the sun, in addition to visible light, radiations of both shorter and longer wave length than we can see. That of *shorter* wave length, the ultraviolet radiation, has rather profound effects upon living matter. It rapidly destroys bacteria and other micro-organisms. It is responsible for what we erroneously call sunburn, which is really not a burn in the ordinary sense but a chemical reaction produced without heat by ultraviolet radiation. One of the vitamins essential to normal bone growth in animals is produced by these rays from substances physiologically inert until they absorb ultraviolet light, and there are other biological effects of this region of the spectrum which we are just beginning to understand.

It has been found that not all the ultraviolet radiation from

[1] Presented at the Rochester Regional Meeting Dinner, March 9, 1938.

[2] Professor of Physiological Optics, Institute of Optics, University of Rochester.

the sun has these effects. The long wave length limit of the ultraviolet is set by the violet limit of the visible spectrum, namely, that region where the sensitivity of the human eye drops substantially to zero, at a wave length of about 4000Å. From this wave length into the ultraviolet to about 3150Å the solar spectrum is without known specific biological effect, although the bulk of the ultraviolet energy reaching the earth's surface lies within these limits. At wave lengths shorter than about 3150Å, biological effects, such as production of sunburn in skin, the destruction of bacteria and other micro-organisms, and the photochemical production of the antirachitic vitamin D increase rapidly.

Just at this point of the ultraviolet region, where the sun's spectrum becomes so interesting, it terminates abruptly. We can produce shorter wave lengths artificially but cannot detect them in sunlight. This abrupt termination of the spectrum at a certain wave length is not characteristic of such a light source as the sun. Furthermore, it has been found that the spectrum of all the heavenly bodies, including widely different types of stars, ends at this same wave length. There can be only one conclusion. Something in the earth's atmosphere, something quite invisible to us, absorbs these shorter wave lengths so strongly that no trace of them has been definitely detected.

This is more surprising when it is realized that air at the earth's surface is transparent to such short wave lengths. This is true even of great masses of surface air such as contained in a horizontal light path many miles in length, much more than the equivalent, weight for weight, of the total thickness of air between the earth's surface and outer space. It had been suspected, and in 1920 was conclusively demonstrated by two French investigators, Charles Fabry and H. Buisson, that the absorbing something was ozone, common oxygen except that three atoms are linked together to form the molecule instead of the ordinary two. Since this ozone is not present near the earth's surface they concluded that it must exist at high levels in the earth's atmosphere.

Fabry and Buisson not only demonstrated the existence of this ozone in the atmosphere, confirming earlier qualitative work of Hartley but, by optical methods, they measured its amount, although it lay no one knew how many miles above them. The quantity they found, forming this dense opaque barrier, when reduced to the pressure of the air at the earth's surface, amounted to a layer of the pure gas 3 mm., or $\frac{1}{8}$ in. thick! This does not mean that the ozone in the atmosphere is confined to so thin a layer of air. The fact that it exists at a high altitude means that the pressure and density are correspondingly low. Moreover, the ozone is diluted with very large amounts of the other air gases, so that the ozone-containing layer of the atmosphere may be a number of miles in thickness, although the total amount corresponds to only the thin layer of the pure gas.

It seems incredible that so small a quantity of ozone can have such a profound effect, but this is confirmed by laboratory measurements on this gas. If this amount were to be reduced to one third our skins would be destroyed in a matter of minutes exposure to the sun. On the other hand if the $\frac{1}{8}$ in. of ozone were doubled, the human race would probably die for lack of an essential vitamin, always supposing that we could survive the enormous increase in bacterial growth which this thicker ozone layer would permit. Somewhat smaller fluctuations in the thickness of the ozone layer do actually occur, observed amounts varying from a lower value a little less than two millimeters to an upper value of a little more than three. In general ozone is greater in the spring than in the fall, and is least in the tropics where its amount varies little throughout the year.

The amount of ozone in the asmosphere is determined from intensity measurements at two or more wave lengths in the sun's ultraviolet spectrum. One wave length not absorbed by ozone is selected, together with another wave length which is strongly absorbed by ozone, the amount of this absorption per unit thickness of gas being determined by laboratory measurements on ozone artificially produced. From the ratio of the intensities of these two wave lengths as observed in the sun's spectrum the amount of ozone in the atmosphere can then be computed.

The height of this ozone has been estimated from ground observations by several different methods, all of them indirect. These estimates place the bulk of the ozone from 10 to 40 miles above the earth's surface. In 1934 and 1935 the vertical distribution was measured directly on the two National Geographic-U. S. Army Air Corp stratosphere balloon flights. A few days after the first of these the same quantity was measured at even greater height, but with less accuracy, with a small sounding balloon instrument released by the Regeners in Germany.

There is another problem connected with the light we receive from the sun, the solution of which appears possible only by the utilization of sounding balloons. The intensity of radiation received by the earth from the sun is very nearly constant, even though the quantity of sunlight which reaches the earth's surface is quite variable due to atmospheric changes. But when the intensity of sunlight is measured accurately and due allowances made for losses in the earth's atmosphere and for the change in the earth's distance from the sun due to the eccentricity of the earth's orbit, there appears a small fluctuation which can be accounted for only by a change in the absolute emission of radiation from the sun itself. In other words the sun appears to be a slightly variable star.

Such a small variation may be of great importance in determining temperature distribution and other conditions on the earth, and many years of study and measurement have been devoted to this problem by the Smithsonian Astrophysical Observatory under the leadership of Dr. C. C. Abbot. Very ingenious methods have been devised for the daily and even hourly measurement of the transmission of sunlight through the earth's atmosphere so that, with a knowledge of the intensity reaching the earth's surface, the amount emitted by the sun and reaching the outside of the earth's atmosphere can be calculated. But in spite of many refinements some uncertainty still remains in the atmospheric transmission coefficients at even the most favorably situated observing stations, and it is desirable that additional measurements be secured by instruments carried to such high levels in the earth's atmosphere that uncertainties due to dust and haze contamination of the lower atmosphere are eliminated. It is the equipment used to solve this problem which I shall use tonight to illustrate the modern sounding balloon method. Since this problem is in many respects more difficult than any which have thus far been attacked by balloon instruments, it involves practically all of the refinements so far developed in balloon technique.

The problems encountered in high altitude work will be better understood from a consideration of a few facts about our atmosphere.

The air surrounding the earth, composed chiefly of nitrogen and oxygen, would expand without limit into outer space were it not for the gravitational attraction of the earth. This attraction upon each molecule of air balances the expansion of the gas, and since the lower layers are subjected not only to this force but to the pressure of the layers above, they are compressed according to an exponential law. If the temperature at all levels were constant, the law could be expressed very simply, especially for elevations in the atmosphere small compared to the earth's radius. For this condition each unit increment of elevation would reduce the atmospheric pressure and density by a constant fraction of itself. This law is modified somewhat because the temperature is not a constant. The actual change of pressure with height is shown by the curve *P* in Fig. 1.

The change in temperature with height for the standard atmosphere is shown by the curve *T* in Fig. 1. This represents only an average or somewhat arbitrary standard, since the actual temperature may fluctuate considerably, especially in the lower atmosphere. The vertical temperature gradient is of much practical value in weather forecasting, and is another reason for interest in the upper air.

The humidity ordinarily diminishes rapidly with increase in elevation. The curve *H* shows an average value of water vapor content with height, but this too is subject to large fluctuations. The vertical humidity gradient, like the temperature, is of very great meteorological value.

Cloud masses may occur at widely differing heights. Cumulus clouds, the puffs of cotton on a summer day, are found at 5000 to 10,000 ft. above the surface, while light cirrus clouds occur at 30,000 ft. and even higher.

It will be noted from Fig. 1 that the temperature, which has fallen with increase of height up to about 30,000 ft. or so, becomes quite constant above this level. This transition level is known as the tropopause, the air beneath it the troposphere, and that above the stratosphere or isothermal region. Our "weather" occurs within the troposphere, although it is undoubtedly influenced by conditions in the stratosphere above. Conditions in the stratosphere are relatively steady, and it was assumed until recently that the stratosphere wind velocities are always very moderate. However, after watching a sounding balloon in the stratosphere over Rochester travel eastward at 135 mi. per hr., one is easily convinced that this former view is somewhat in error.

In addition to nitrogen and oxygen the atmosphere contains small quantities of carbon dioxide and hydrogen, and of argon and the other inert gases. The distribution of these with height would be computable from their relative densities if no vertical stirring occurred. That vigorous vertical stirring does occur is shown by the fact that, instead of obeying such a law, the relative composition of the atmosphere is almost unchanged up to heights of 100,000 ft.

Water vapor and ozone have already been mentioned. The water vapor content at high altitudes is low because of the low temperatures prevailing, any excess vapor carried up by vertical currents being precipitated out as water droplet or ice clouds. The ozone in the air owes its origin to dissociation of a small part of the oxygen, and it is now quite well established that this dissociation is produced by ultraviolet

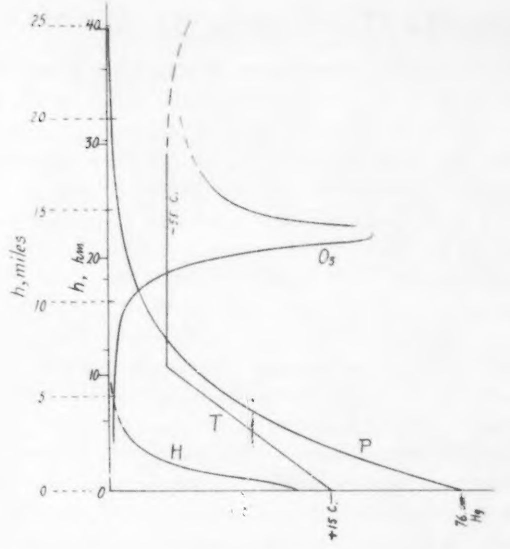


Fig 1. Curves Relative to Altitude in Kilometers

P—Atmospheric Pressure	**H—Water Vapor Content**
T—Temperature	**O_3—Ozone Concentration**

light from the sun, but of shorter wave lengths than ever reach the earth's surface. Uultraviolet light of slightly longer wave length is absorbed by ozone, and in turn decomposes it. It is the balance between this formation and decomposition of ozone by two slightly different wave length regions in the sun's ultraviolet spectrum which results in the peculiar vertical distribution of ozone shown by the curve O_3 in Fig. 1, as we measured it on the stratosphere balloon flights of 1934 and 1935.

The pressure curve of Fig. 1 also represents very nearly the relative density for altitudes above 35,000 ft., since the temperature is nearly constant for a long distance above this level. It will be noted that here the density of the air halves for each increase in height of 14,500 ft. Thus the volume of a balloon containing a given weight of hydrogen or helium must double each time the altitude increases by this amount, although its lifting power will remain constant. The limiting altitude which a balloon may reach is thus established if we know only the weight of balloon envelope and load which must be sustained, and the maximum diameter which the balloon envelope may attain.

EDITOR'S NOTE.—The discussion of balloon technique and instruments included vented balloons with non-expanding envelope, spherical at takeoff, the same type of balloon under-inflated at takeoff (the man-carrying stratosphere balloon), and spherical balloons with resilient expanding envelopes such as the rubber balloons used to carry small automatic instruments.

The discussion of instruments was confined to those suitable for small sounding balloon work, since these represent the most unusual development, in view of the severe limitations in weight (usually 2 to 5 lb. total). As an example of this class the automatic ultraviolet photometer instrument of the Institute of Optics was exhibited and described in some detail. This instrument, receiving ultraviolet radiation from the sun, actuates, through a photocell and amplifier, a small radio transmitter also carried by the balloon. The radio signals, received on the ground actuate an automatic recorder, and provide an accurate permanent record of the solar intensity at each altitude. These instruments have been flown to altitudes of 70,000 ft. with excellent radio recording at the ground.

Important Work at Committee Week in Rochester

Numerous Actions on Standards to Be Recommended; Research Work Progresses

There were more meetings of A.S.T.M. standing committees and their subgroups and sections during 1938 Committee Week in Rochester, N. Y., extending from March 7 to 11 inclusive, than in any similar series in previous years. At the upwards of 165 meetings, a number of new specifications and tests were approved and will be submitted to the Society at the annual meeting in June, subject to approval by confirming letter ballot of the respective committees. Likewise, numerous existing specifications and tests in the tentative stage are to be voted on for adoption as standard.

The total registration for Committee Week was 662, a new high, comparing with 626, the previous top at Pittsburgh in 1936. All of the meetings were well attended, with interesting discussion on a number of important points. Organization was perfected of two new standing committees, on thermal insulating materials and on radiographic testing as outlined in separate articles in this BULLETIN.

The following committees held meetings and in the case of most of those listed a large number of subcommittee meetings were held prior to the main committee session:

- A-1 on Steel
- A-2 on Wrought Iron
- A-3 on Cast Iron
- A-5 on Corrosion of Iron and Steel
- A-7 on Malleable Iron Castings
- A-10 on Iron-Chromium-Nickel Alloys
- B-1 on Copper and Copper Alloy Wires for Electrical Conductors
- B-2 Sub II on Refined Lead, Tin, Antimony and Bismuth
- B-3 on Corrosion of Non-Ferrous Metals
- B-5 on Copper and Copper Alloys
- B-6 on Die-Cast Metals and Alloys
- B-7 on Light Metals and Alloys
- C-14 on Glass and Glass Products
- C-16 on Thermal Insulating Materials (organization meeting)
- D-1 on Paint, Varnish, Lacquer
- D-3 on Gaseous Fuels
- D-4 on Road and Paving Materials
- D-5 on Coal and Coke
- D-6 on Paper and Paper Products
- D-8 on Bituminous Waterproofing Materials
- D-11 on Rubber Products
- D-17 on Naval Stores
- D-18 on Soils for Engineering Purposes
- D-20 on Plastics
- Sections of Com. E-1 on Methods of Testing:
  - Tension Testing
  - Indentation Hardness
  - Effect of Speed of Testing
  - Elastic Strength of Materials
  - Calibration of Testing Machines
- E-1 Special Committee on Study of Softening Point Test
- E-1 Technical Committee XII on Laboratory Glassware (formerly Committee D-15 on Thermometers and Laboratory Glassware)
- E-2 Sub III on Quantitative Methods and Applications of Spectrographic Analysis
  - Sub V on Standards and Pure Materials used in Spectrographic Analysis
- E-4 Sub IV on Photography
  - Sub VI on X-ray Methods
- E-7 on Radiographic Testing
- Research Committee on Fatigue of Metals
- Joint Committee on Effect of Temperature on the Properties of Metals
- B-36 Sectional Committee on Wrought-Iron and Wrought-Steel Pipe and Tubing
- G-8 Sectional Committee on Specifications for Zinc Coating of Iron and Steel

The outlines given below of various committee activities will give some idea of the progress made and of the programs which the committees have under way. In addition to statements of many of the above committees, there are also included in the material data on actions reported by Committees B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys and D-12 on Soaps and Other Detergents as a result of meetings held in New York City.

Most of the actions taken at the meetings will, of course, be submitted to letter ballot prior to formal recommendation to the Society at the annual meeting in June in Atlantic City, this being particularly true in the case of actions in the standardization field. It will be noted that many new standards are being considered for recommendation to the Society for publication as tentative and that a number of existing tentative specifications and tests will be offered for formal adoption as A.S.T.M. standards.

Committee A-1 on Steel

Subjects of predominating interest at the fifteen meetings of A.S.T.M. Committee A-1 on Steel and its sections were the so-called low-alloy steels and welding. A number of tentative specifications issued in previous years, covering important products, were recommended for adoption as standard and changes are to be made in other specifications. Included in the list to be adopted are those covering the following materials: structural nickel steel (A 8), seamless cold-drawn alloy-steel (4 to 6 per cent chromium) heat-exchanger and condenser tubes (A 187), seamless alloy-steel (4 to 6 per cent chromium) still tubes for refinery service (A 188), molybdenum-steel plates for boilers and other pressure vessels (A 204), chrome-manganese-silicon (CMS) alloy-steel plates for boilers and other pressure vessels (A 202), carbon-silicon-steel plates of ordinary tensile ranges for fusion-welded boilers and other pressure vessels (A 201) and cold-rolled strip steel (A 109).

In the field of structural steel, the committee will continue studies of steel piling, structural bolts and high-strength rivets.

Extensive revisions in the form of a new tentative specification of the standard for normalized-quenched and tempered alloy-steel forgings (A 63) are to be recommended.

The specifications for lap-welded and seamless steel boiler tubes (A 83) are to be revised to include the new system of indicating wall thicknesses by decimals (with the nearest B.w.g. given for information). Sizes from $\frac{1}{2}$ to 6 in. O.D. and walls from 0.035 to 0.320 are covered. A new system of tolerances by percentages is to be inserted. The Grade C tubes (medium carbon steel) are to be covered in a new specification. The tentative specifications for seamless steel boiler tubes for high-pressure service (A 192 - 36 T) are to be revised to cover material up to 1 in. in wall thickness.

Additional studies will be made on standardizing requirements for the three different types of spiral pipe now commercially produced. Substantial agreement has been reached on new specifications for carbon-molybdenum steel boiler and superheater tubes, and they are expected to come up for action at the June meeting in Atlantic City. A separate standard for medium carbon tubes will be developed, with maximum carbon of 0.35 per cent, minimum tensile strength of 60,000 lb. per sq. in., and O.D. size range of $\frac{1}{2}$ in. to 5 in. incl.

As a result of discussion of the use at sub-zero temperatures of plate material for pressure vessels, etc., the Steel Committee members were urged to submit any data they have on the subject to Col. G. F. Jenks, Ordnance Dept., U. S. Army, Washington, for study in connection with the

Symposium on Impact Testing to be a feature of the A.S.T.M. meeting in June.

Changes published last year involving the scope clauses and chemical composition of high tensile strength carbon-silicon steel plates up to 2 in. in thickness (A 149) and over 2 to 4 in. in thickness (A 150) were recommended for adoption.

Since recent research has indicated that in tensile testing the rate of loading is preferable to the free crosshead speed as a method of limiting the speed in the determination of yield point, the various A-1 subcommittees for particular materials are to study the applicability of the method.

Discussion of the utility and extent of use of the specifications for commercial bar steels (A 107, hot-rolled; A 108, cold-finished bars and shafting) indicated they serve a distinct purpose and are in considerable use, particularly the latter.

A preliminary study of the some one hundred specifications in the charge of Committee A-1 indicated that about 50 covered materials which had been successfully welded and that about 20 others were for material which seemed to be weldable, possibly with minor changes in the present requirements. Detailed studies of this subject are to be made by the subcommittee in charge, with specific sections assigned to particular classes of material. The committee is following with much interest research work on welding, particularly to solve questions on the carbon-manganese ratio. The Welding Research Committee under the joint auspices of the American Welding Society and the American Institute of Electrical Engineers is sponsoring such a program.

Further studies will be made of specification drafts for welding grades of carbon-steel castings and carbon molybdenum alloy-steel castings for high-temperature service, particularly on impurity elements and welding technique. Numerous proposed changes were recommended to be published as tentative in standards for alloy-steel castings for valves and fittings for service from 750 to 1100 F. (A 157), lap-welded and seamless steel pipe for high-temperature service (A 106) and forged or welded pipe flanges (A 105).

A new class of nut, carbon-molybdenum composition, will be incorporated in the high-temperature nut specifications (A 194), with other proposed modifications.

To meet demands for standard material requirements for welded-end fittings, a section is drafting a proposed standard to be given consideration by the committee.

Committee A-2 on Wrought Iron

There were approved for reference to letter ballot for immediate adoption revisions in the table of dimensional requirements appearing in the specifications for welded wrought-iron pipe (A 72). The changes will remove the butt weld requirements for sizes $2\frac{1}{2}$ and 3 in. from all of the three weight classifications, since butt weld wrought-iron pipe is not made in these sizes. In the case of double extra strong pipe the requirement for $1\frac{1}{2}$-in. lap-welded pipe will be deleted.

Proposed revisions of the specifications for staybolt wrought iron, solid (A 84) and for staybolt wrought iron, hollow rolled (A 86) involve permissible variations in dimensions. Before final action is taken on the contemplated changes the matter will be considered by the specifications committee of the Association of American Railroads.

Committee A-3 on Cast Iron

The committee on cast iron reviewed various subcommittee activities. In the field of pig iron, the section in charge has been reorganized and is investigating specification requirements. Two new subcommittees are to be appointed covering soil pipe and pressure pipe and a new group has been appointed to investigate the 2 in. transverse test bar of the 60,000 lb. per sq. in. class in the specifications for gray-iron castings (A 48). The section on white and chilled cast iron held its first meeting, at which there was outlined a research program to evaluate properties of this class of irons.

Committee A-7 on Malleable Iron Castings

The principal activity reported at the meeting of Committee A-7 involved the work of Professor Landon of Southern Methodist University on recognition of the yield point of malleable iron. The results of the investigation are expected to be referred to the subcommittee on methods of test in the near future. A new subcommittee has just been organized to cover welding. A paper is to be prepared by Professor Enrique Touceda, covering quenching temperature in treatment for prevention of galvanizing embrittlement. This paper is expected to be presented under the sponsorship of the subcommittee on galvanizing.

Committee A-5 on Corrosion of Iron and Steel

The series of meetings sponsored by Committee A-5 were active ones and well attended. The inspection of the extensive and country-wide outdoor tests have been made throughout the year. These tests include work on bare and galvanized sheets and hardware.

The committee anticipates an inspection of corroded specimens in the new wire tests in April of this year when the first samples will be removed from the racks at Pittsburgh. All of the test stations have been inspected from a visual standpoint at least once. Referee testing, both physical and chemical, of all wire test material has been completed by the National Bureau of Standards, and the complete data are expected to be published in the 1939 annual report of the committee.

Proposed new tentative specifications covering galvanized sheets will be recommended to the Society for publication as tentative, with the probability that they will eventually supersede the existing standard specifications (A 93 - 27) which cover sheets with five classes of zinc coatings prepared by the hot dipped process.

After approving certain changes in the Method of Test for Uniformity of Coating by the Preece Test (Copper Sulfate Dip) on Zinc-Coated (Galvanized) Iron or Steel Wire (A 191 - 36 T) the method was approved for recommended adoption as standard.

In order to meet the demands for a test procedure for determining thickness of zinc coating on zinc-coated (hot galvanized) irregular shaped hardware, especially steel castings and forgings, and gray iron and malleable iron castings, the committee has developed a proposed Preece test procedure which is to be referred to the Society for publication as tentative. This test has been investigated intensively by various members of the committee, particularly those in a special section of Subcommittee VII on Test Methods under the chairmanship of F. L. Wolfe. In recommending the

new method, the committee discussion made it clear that stripping methods as described in the Methods of Determining Weight and Uniformity of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles (A 90 - 33) should be continued for iron and steel hardware conforming to the general description of bolts, nuts, nails, etc., and other parts which have uniform or easily estimated surface areas.

Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys

The subcommittee collecting and correlating authoritative basic data on the chromium and chromium-nickel corrosion-resisting alloy steels reported that the work of the eight subdivisions into which the alloys included in the survey have been divided is progressing satisfactorily. The information being obtained will include data on chemical, physical, mechanical and fabricating properties of the alloys.

A special committee reported the completion of inspections of the stainless steel installations on the exteriors of the Chrysler and Empire State Buildings in New York City. The information obtained will be supplemented by inspections of other installations of stainless steel on buildings of smaller size. Following completion of these inspections, the behavior of the corrosion-resisting steels under conditions of actual service installations will be correlated with the previous manufacturing history of the materials, and the results of these surveys when completed should be of considerable interest and assistance to the architectural and engineering professions, in connection with future building construction.

The committee reported the preparation of a recommended procedure for making atmospheric field corrosion tests of stainless steels. This was accepted for detailed study by the members of the committee and others interested in this subject.

The subcommittee on metallography reported the completion of a microscopic examination of 18 per cent chromium, 8 per cent nickel steel after various heat treatments. Two heats of these alloy steels containing, respectively, 0.065 per cent and 0.098 per cent carbon, were examined and photomicrographs prepared at magnifications of 100 and 750 diameters. The data and information obtained are now being studied by the committee in an effort to determine the nature of the grain boundary precipitation of austenitic steels of this type.

In the work on specifications for flat products there were reported revisions in the existing tentative specifications for corrosion-resisting chromium-nickel steels (sheet, strip and plate) (A 167). The subcommittee on specifications for tubular products is preparing, with the cooperation of the American Petroleum Institute, proposed specifications for corrosion-resisting chromium-nickel alloy steel seamless still tubes for petroleum refinery installations.

Committee B-1 on Copper and Copper Alloy Wires for Electrical Conductors

Committee B-1 discussed proposed revisions in the specifications for bare stranded copper cable: hard, medium-hard or soft (B 8). It is planned to amplify the section covering joints to obviate possible misinterpretation and unless the direction of lay is specified by the purchaser, the requirements in the specifications will be set up to provide for left-hand lay of the outer layer of wires. Changes will require tagging or marking of both the cable and the reel or container, and also suggestions as to desirable package length and reel dimensions for Class AA hard or medium-hard bare cables.

Minor changes in resistivity requirements of Grade Nos. 9, 13 and 15 in the tentative specifications for hard-drawn copper alloy wires for electrical conductors (B 105) are to be recommended. Also it is proposed that Grade No. 9 be changed to Grade No. 8½ with corresponding changes in resistivity and tensile strength. (The ten grades of alloy wires covered in the specifications have been designated Grade Nos. 9 to 85 in accordance with their increasing conductivity.)

A section is being appointed to recommend maximum pulling speeds in testing hard and medium-hard wires for tensile strength and elongation.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys

The matter of chief interest discussed by Committee B-3 was the work on atmospheric tests. The 1938 annual report will present the results of the third series of tests made on twenty-four non-ferrous metals and alloys exposed in 1931 to various atmospheres at nine test locations. The program of the subcommittee contemplates making five such tests at various intervals of time over a twenty-five year period. Three sets of tests have been made to date after exposure intervals of approximately one year, three years, and six years.

In the latest tests the extent of corrosion has been determined by the same procedure used in the previous tests, namely, by measuring the changes in weight of duplicate 9 by 12-in. plate specimens, by visual examination of these plates and by determining the changes in tensile strength and per cent elongation of tension test specimens.

Various types of copper alloys, bronzes, aluminum and aluminum alloys, brasses, nickel and nickel alloys, lead, zinc, and their alloys are included. There are four plate specimens of each material at each of the nine test locations, thirty tension test specimens, and an extra set of thirty tension specimens was prepared and stored, under air-tight conditions at the National Bureau of Standards. The two "removable" plate specimens are returned to the Bureau for inspection and weighing. At the same time that the set of tension test specimens which are exposed are tested, six specimens of each material are removed from the set stored at the Bureau in air-tight containers and their tensile properties determined. This phase of the work indicates what changes may have taken place through simple aging.

Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys

As a result of consideration by Committee B-4 during its session at the A.I.M.E. annual meeting in February, in New York City, a number of recommendations on standards in the jurisdiction of the committee are to be made to the Society. A revision in the accelerated life test for electrical heater wires (B 76 – 36) will provide that there be a glass front around the test specimen in order to insure a more uniform temperature.

(*Continued on page* 28)

Certain Topics at International Testing Congress Summarized

Briefs by Group Presidents Afford General Picture of Progress

There has recently been issued the publication covering the sessions and papers and discussions presented at the 1937 London Congress of the International Association for Testing Materials held under the auspices of the committee representing the British members of the Association. While it is obviously impossible in four or five pages adequately to summarize the more than 200 papers which were presented, it is felt many of the A.S.T.M. members would find of some interest a brief review of the papers in the various groups.

Following the procedure of past congresses the officers of certain of the groups have summarized the papers and have given the general trend of progress.

Copies of the extensive I.A.T.M. Proceedings, in cloth binding, can be obtained from the secretary of the London Congress, K. Headlam-Morley, The Iron and Steel Institute, 28 Victoria St., London, S. W. 1, England, at $7.75 each. This price includes prepayment of postage.

(Editor's Note: In reprinting material, some liberties have been taken to make the material conform generally to Bulletin editorial style, but in large part the material is reprinted directly from the Congress Book.)

Summary Regarding the Behavior of Metals as Dependent on Temperature

MECHANICAL PROPERTIES

The Group President, Prof. C. Benedicks (Sweden), wrote as follows: As for *Creep in General*, the establishment of "creep recovery," *i.e.* a contraction, taking place when the load on creep specimens (Tapsell) was removed, was an important addition to our knowledge. It should not be forgotten, however, that in itself, this phenomenon belonged to the group of phenomena known and studied long ago as "after-action," or "Nachwirkung." This phenomenon, in the discussion, was compared with the slight increases in specific gravity, *i.e.* contraction, which was known to occur in a deformed metal when annealed. In order to explain theoretically such a contraction, several hypotheses were proposed. Attention was drawn to the eventual action of surface tension.

Though the importance of creep was universally recognized, its seriousness in practice should not be overrated, as pointed out in the discussion.

Regarding *creep-testing methods*, the much-debated question of short-time tests *versus* long-time tests had received, in the President's opinion, an important advance in the Report on the methods used at the Poldihutte. By means of an extrapolation—which seemed to be quite permissible—the limiting stress corresponding to the creep velocity zero ("Dauerstandfestigkeit") was obtained. These values were then plotted as a function of the temperature. Using this procedure, "short-time tests" and "long-time tests" belonged to one and the same curve; the form of this having once been established for a given steel—whereby long-time tests could not be dispensed with—short-time tests would be reliable.

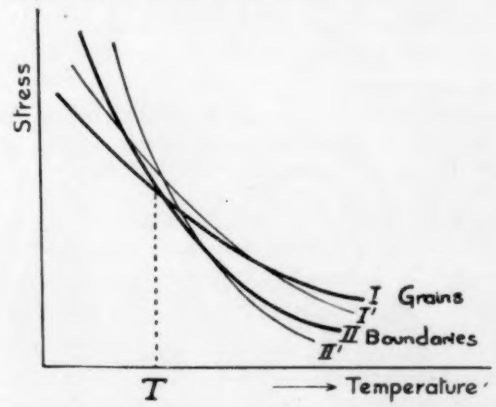
The results agreed well with those obtained at the Kaiser-Wilhelm-Institut in Dusseldorf, which was gratifying. For the determination of (1) yield point at high temperatures (Warmstreckgrenze) and (2) "time yield" (Dauerstandfestigkeit), as carried out in Germany, accurate specifications had been worked out by the Verein deutscher Ingenieure (1935, 1936).

It was pointed out in one paper (Bailey) that the addition of 1 per cent chromium actually lowered the heat resistance of a 0.5 per cent molybdenum steel at 500 C. Likewise, the addition of nickel had been found to exert no good influence. Thus, the purer the molybdenum steel, the better it seemed at high temperature.

On the contrary (as pointed out by Hatfield) 0.86 per cent titanium and 1.5 per cent aluminum added to an 18 per cent chromium – 8 per cent nickel steel had been found greatly to improve its resistance to creep. No explanation was given.

The following points of view therefore seemed to be of interest:

Mention was made in several papers of the so-called equicohesive temperature *T*. As illustrated by Fig. 11, this temperature was the section of two curves, I and II. I represented the strength of the (interior of the) grains of a metal, decreasing with increasing temperature at a certain rate; II represented the strength in the grain boundaries. On account of the enrichment in foreign substances here, the boundaries had a special strength at low temperatures, whereas at high temperatures—in connection with the lowering of the melting point—the strength was much lower than that of the interior of the grains. It was on account of these conditions that the fracture at low temperatures generally passed through the grains and at high temperatures through the boundaries.



Adding now, say as above, 1 per cent chromium to the steel—assumed to contain molybdenum—curve I would be more or less higher at low temperatures (increased strength) and lower at high temperatures (lowered melting point); a curve I′ resulted. Similarly for curve II, which would give a curve II′, with more slope than before.

The net result of the addition obviously would be that the addition of chromium would prove ***beneficial in a low temperature range*** but ***detrimental in a high temperature range***, as had actually been found.

In order to increase if possible the strength, and also the creep resistance, it was obviously desirable that all the curves should be displaced as much as possible in the direction of higher temperatures. Hence, all additions which lowered the melting point of the alloy should be decreased, and instead, additions which raise the melting point should be made.

The applicability of this conclusion, implying the introduction of a considerable amount of tungsten, would be restricted by economic reasons. Consequently, it was noteworthy that there apparently existed other, more economical, methods of increasing the creep resistance, not hitherto sufficiently elucidated, though already used in practice.

The addition of a certain amount of a substance which, in itself not refractory, was able to form and precipitate a refractory compound with the components, would probably increase the creep resistance. This seemed to be true for the interesting alloys discovered and described by Professor Chevenard; they were obtained on adding 5 per cent aluminum to an alloy of 60 per cent nickel, 10 per cent chromium and 30 per cent

iron; here the refractory compounds AlNi (melting point 1640 C.) of $AlCr_3$ (above 2000 C.) possibly were formed successively.

Still another possibility merited mention. When, as stated by Doctor Hatfield, additions of as little as 0.86 per cent titanium and 1.5 per cent aluminum had been found to increase creep resistivity enormously, this could hardly be explained in the above way, *i.e.* through the precipitation of some hard phase. Here, however, attention might be paid to a theory which had been recently advanced by C. Benedicks in collaboration with H. Lofquist.

In fact, even small additions to a metal of certain dissolved substances must be expected to accumulate by capillarity in the grain boundaries. When the substance in itself could form a hard or refractory layer, even atomically thin, *this "stabilization" of the boundary had been found effectively to inhibit grain growth.*

Such appeared to happen with the small amounts of aluminum and titanium added to steel; on combining with nitrogen, which always occurred in steel, very resistant nitrides were formed.

Accordingly, it was reasonable to suppose that even atomically thin boundary layers of such substances could exert a noticeable *influence on creep*, for which phenomenon a stiff "boundary skeleton," even though not in the shape of a precipitated phase, must be expected to be an inhibitor. The latter point of view seemed to possess a certain importance for heat-resisting alloys.

CHEMICAL PROPERTIES

As for *Oxidation and Corrosion in General* at high temperatures, a general review of the factors concerned was given by Dr. U. R. Evans. Corrosion, generally increasing with increasing temperature, might also decrease, because oxygen was less soluble at high temperature, and also because of condensation. Besides, it was shown by Benedicks that a factor meriting consideration was the influence of temperature on the electrolytic potential itself, giving rise to local cells; this could cause considerable corrosion in cases of "hot wall effect."

Regarding *Testing Methods and Results*, in a survey of available experimental methods, it was indicated that continuous recording of weight was generally a most useful method for the study of oxidation (Portevin and co-workers).

As alloys suitable for use at high temperatures there were, as mentioned by Doctor Rohn, two main groups of chromium alloys available: (1) chromium-nickel-iron, and (2) chromium-aluminum-iron alloys. For Group 1, 80 per cent nickel, 20 per cent chromium could be looked upon as standard; it could now be used up to 1200 C. For electrical use at 1300 C., or possibly 1350 C., recourse must be had to Group 2, which, however, had but low mechanical strength and became brittle.

As a rational life testing method, Doctor Rohn proposed the intermittent heating of thin wires (spiral) at constant temperatures.

The industrial method most utilized for current wire control seemed to be that described by Mr. Bash, which had been standardized in the United States. An objection was raised in the discussion that this method, implying a creep determination, though working well for the Group 1 alloys, did not do justice to the more deformable alloys of Group 2. This, however, did not exclude its value for routine testing in production.

A valuable life testing method seemed to be that described by Hoyt and Scheil, measuring the time necessary for the electrical resistance to increase 10 per cent at some standard temperature (1260 up to 1425 C.). At the latter high temperature, a life, defined in this way, of 80 hr., was said to be obtained for the alloy specially studied (containing 53 per cent iron, 38 per cent chromium, 8 per cent aluminum). The increase in grain size was reported to be very small. Such a resistance to grain growth would be explained by the theory of grain stabilization already mentioned.

Metallography, Including X-ray Interference, Etc.

PRESIDENT BENEDICKS said that the paper, "Characteristics of the Deformation and Fracture of Metals as Revealed by X-rays," by Dr. H. J. Gough, was one of the most fundamental to be presented to the Congress.

Dr. H. J. Gough said he would like to explain the position in which he and his collaborators found themselves with regard to the use of X-rays for the work in question. Their problem was this: If a piece of metal was taken and broken under any stressing system, what was the actual condition which attended failure? The mechanical methods which they had tried had not given them the answer. The microscopical methods which they tried took them a little further, but still did not provide the answer. He had now, with the assistance of Mr. Wood, made the same study with the use of X-rays. He would like to point out a problem which he hoped that other workers in the field would attack, as he and his colleagues were much more interested in what they had failed to do than in what they had done. Briefly, Mr. Wood and himself had broken pieces of normalized mild steel under five stressing systems. The most useful system, of course, was not a simple static break, but one with which it was possible to delay the fracture for millions of reversals and examine it for fatigue. They found out that, whatever the stressing system, the first thing was that the large grains broke up into two or more fairly large portions. They were not tipped very much—never more than 2 deg. away from each other. In addition to that, a large number of very tiny pieces was formed, the orientation of which was entirely haphazard. That went on until, when fracture was reached, either the whole of the material (in the case of a simple static stress system) or a part of the material (in the case of some form of alternating stress system) got to that stage, and therefore from the original X-ray picture *A*, one obtained a picture *B*. That was very nice, but what he wanted to know was this: If *B* corresponded to the fracture stage of a 0.1 per cent carbon steel in the normalized condition, and if a bar of that 0.1 per cent carbon steel in the normalized condition was passed through a roll and then X-rayed, something like *B* was obtained again, which he would call *C*, and yet the strength of one might be four or five times that of the other. Its fatigue and static strength had increased; there was a loss in ductility, but in every way it was strengthened. The problem on which they were now working was to find what was the slight difference between *B and C; C* actually must undergo some further change before it got to the stage of fracture. He believed that most of the change was vitally concerned with the true conditions of fracture.

They had not done enough, since the work published in the paper, to be able to say what actually happened, but he could give the assurance that when one did finally fracture *C* under various stress systems, one did not, for example, obtain preferred orientation, and the result *D* was only very slightly different from *C*. The work was so recent and incomplete, however—the results were obtained only a week before the Congress—that they were not in a position to say definitely what was the essential difference between *D* and *C*.

Light Metals and Their Alloys

IN a critical review of this subject the President wrote:

(*a*) The most prominent point was the gratifying fact that there seemed now to be a fairly good agreement as to the actual *signification of age-hardening*, as being due to an intermediate state between the homogeneous solid solution and the actual precipitation, characterized by the *formation of germs in the solid solution.*

(*b*) The seven papers on *aluminum alloys* contained valuable

(Continued on Page 35)

Velocity of Settlement of Soil Particles in Water

By T. H. Evans[1]

In the widely used hydrometer method for completing the mechanical analysis of a soil sample, the basic mathematical principle underlying the method is the so-called "Stokes' law." This law, however, usually gives an expression for particle size in terms of a terminal velocity which is the constant velocity attained in a viscous medium when the resisting forces finally balance the propulsive forces. In other words the acceleration becomes zero.

In the formula based on Stokes' law, and which is recommended for use by the American Association of State Highway Officials and also given in the Tentative Method of Mechanical Analysis of Soils (A.S.T.M. Designation: D 422),[2] it is tacitly assumed that this terminal velocity is equal to the distance through which the particles fall, divided by the time of fall. This is only true, of course, when the velocity is constant throughout the *entire drop*. But for the particle sizes determined by the hydrometer method it is proved below that the substitution is justified for all practical purposes.

One fundamental assumption made by Stokes in deriving his relationship was that the particles were spherical. Based on other assumptions he also found the viscous resistance to motion to be given by $3\pi Dnv$ dynes.

Thus $R = 3\pi Dnv$, where D = diameter in centimeters, n = viscosity in poises, and v = velocity in centimeters per second.

Also $B = \frac{1}{6}\pi D^3\rho_f$, and $W = \frac{1}{6}\pi D^3\rho_s$, where

B = buoyancy of suspending medium, W = weight of particle, and ρ_f and ρ_s = the densities of fluid and solid respectively, in grams per cubic centimeter.

In Fig. 1, L_t and L represent distances of fall to reach the terminal velocity and the bottom of the container, respectively. V_o is the initial velocity, assumed to be zero in this analysis; V_t is terminal velocity; and V any velocity, in centimeters per second.

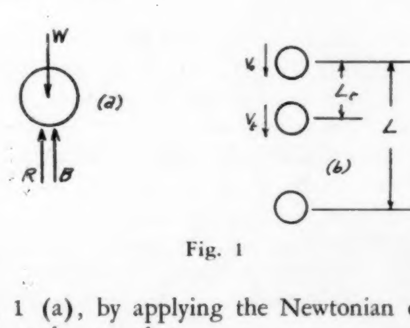


Fig. 1

In Fig. 1 (a), by applying the Newtonian equation of motion, it can be seen that

$$a = \frac{\Sigma F}{M} = \frac{W - (B + R)}{W} \times g$$

$$= g\,\frac{\left[\frac{1}{6}\pi D^3\rho_s - \left\{\frac{1}{6}\pi D^3\rho_f + 3\pi Dnv\right\}\right]}{\frac{1}{6}\pi D^3\rho_s}$$

$$= g\left[1 - \left\{\frac{\rho_f}{\rho_s} + \frac{18nv}{D^2\rho_s}\right\}\right]$$

Thus, when $a = 0$, and $v = v_t$ or $W = B + R$

$$0 = 1 - \frac{\rho_f}{\rho_s} - \frac{18nv_t}{D^2\rho_s}$$

from which $v_t = \dfrac{(-\rho_s + \rho_f)\,D^2\rho_s}{-\rho_s\,18n} = \dfrac{D^2(\rho_s - \rho_f)}{18n}$ . . . . (1)

This is the usual form of Stokes' law.

In order to find the time to acquire any given velocity the relationship $a = dv/dt$ will be used.

It follows, then, that

$$g\,dt\left[1 - \left\{\frac{\rho_f}{\rho_s} + \frac{18nv}{D^2\rho_s}\right\}\right] = dv$$

or $g\,dt = \dfrac{dv}{1 - \left\{\dfrac{\rho_f}{\rho_s} + \dfrac{18nv}{D^2\rho_s}\right\}}$

If $A = 1 - \dfrac{\rho_f}{\rho_s}$, and $C = -\dfrac{18n}{D^2\rho_s}$ then

$$g\,dt = \frac{dv}{A + Cv}$$

Integrating both sides we have

$$g\int_o^T dt = \int_o^{V_t}\frac{dv}{A + Cv}$$

or $gT = \dfrac{1}{C}\log_e(A + Cv)\Big]_o^{V_t}$ but when $v = v_t$, $A + Cv_t = 0$

$\therefore\; gT = \infty$ . . . . (2)

which is correct for this exponential type of function. For practical purposes, however, it is satisfactory to assume values of v_t (for example, 0.999, 0.990, and 0.900) and calculate the corresponding times. When this is done it can readily be seen that the *v-t* curve approaches *very* rapidly its asymtote $v = v_t$.

$$gT = \int_o^{V_1}\frac{dv}{A + Cv}$$

$$= \frac{1}{C}\log_e(A + Cv)\Big]_o^{V_1} \text{ where } V_1 < V_t$$

$$= \frac{1}{C}\log_e(A + Cv_1) - \log_e A$$

$$= \frac{1}{C}\log_e\frac{A + Cv_1}{A}$$

$$= \frac{1}{C}\log_e\left(1 + \frac{Cv_1}{A}\right) = \frac{1}{C}\log_e\left(1 - \frac{v_1}{v_t}\right) \quad . \; . \; . \quad (3)$$

or $e^{gCT} = 1 - \dfrac{v_1}{v_t}$ . . . . (4)

The type of curve given by this relationship is shown in Fig. 2.

EXAMPLES OF TIME VALUES FOR CERTAIN VELOCITIES

1. Let $D = 0.001$ mm. (lower clay limit), $\rho_s = 2.65$, $\rho_f = 1.00$, and $n = 0.0102$, then $A = 0.623$, $C = \dfrac{-6.93\times10^{-2}}{D^2} = -6.93\times10^{6}$, and $\dfrac{-A}{C} = 8.99\times10^{-8}$ cm. per sec.

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[1] Assistant Professor of Civil Engineering, Department of Engineering, University of Virginia, Charlottesville, Va.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part I, p. 953 (1935); also 1937 Book of A.S.T.M. Tentative Standards, p. 885.

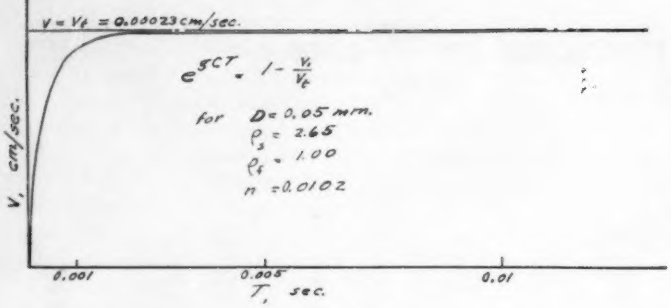


Fig. 2

If $v_1 = 0.999v_t$

$$T = \frac{\log_e (1-0.999)}{-6.19\times10^9} = \frac{\log_e 0.001}{-6.19\times10^9} = \frac{3.0922-10}{-6.19\times10^9} = 1.12\times10^{-9} \text{ sec.}$$

$$v_1 = 0.990v_t \qquad T = \frac{\log_e 0.010}{-6.19\times10^9} = \frac{5.3948-10}{-6.19\times10^9} = 0.744\times10^{-9} \text{ sec.}$$

$$_1 = 0.900v_t \qquad T = \frac{\log_e 0.100}{-6.19\times10^9} = \frac{7.6974-10}{-6.19\times10^9} = 0.373\times10^{-9} \text{ sec.}$$

2. Let $D = 0.05$mm. (upper silt limit), and other values be as above.

Then $A = 0.623$, $C = \frac{-6.93\times10^{-2}}{25\times10^{-6}} = -2.77\times10^3$, and $\frac{-A}{C} = 2.25\times10^{-4}$ cm. per sec.

[3] C. A. Hogentogler and C. A. Hogentogler, Jr., "Engineering Properties of Soil," McGraw-Hill Book Co., New York City (1937).

$$\text{When } v_1 = 0.999v_t \qquad T = \frac{\log_e 0.001}{-2.72\times10^3} = 2.56\times10^{-3} \text{ sec.}$$

$$v_1 = 0.990v_t \qquad T = 1.70\times10^{-3} \text{ sec.}$$

$$v_1 = 0.900v_t \qquad T = 0.849\times10^{-3} \text{ sec.}$$

These examples simply go to prove that by the time the hydrometer is first inserted in the solution all particles within the size limits being analyzed have reached their terminal velocities.

The formula recommended for determining grain size from the time and length of fall is therefore satisfactory from a practical standpoint since $v = \frac{L}{T}$.

$$\therefore \quad D^2 = \frac{18nv}{(\rho_s - \rho_f)} = \frac{18n}{(\rho_s - \rho_f)} \cdot \frac{L}{T} \qquad (5)$$

By the use of the proper conversion factors the form given in Hogentogler[3] or in the A.S.T.M. and A.A.S.H.O. specifications is obtained from Eq. 5, namely

$$d = \sqrt{\frac{30\, nL}{980\, (G - G_1)\, T}}$$

where d = maximum diameter in millimeters, L = length of fall in centimeters, T = time in minutes, and G and G_1 = specific gravity of solid and suspending medium respectively.

International Testing Association Reorganized

At its meeting in London, April, 1937, the Permanent Committee of the International Association for Testing Materials adopted revised statutes changing considerably the organization of the Association. Under these new statutes, personal and company membership have been eliminated and replaced by membership on the part of the national associations for testing materials or their equivalent. Believing that members of the Society would be interested in the revised statutes, they are reprinted in full below.

I.A.T.M. Statutes

Discussed and Agreed at the Meeting of the Permanent Committee of the I.A.T.M. in London, April 17, 1937.

Art. 1.—Name of the Association:
"The International Association for Testing Materials."—I.A.T.M.

Art. 2.—Objects of the Association:
Securing international cooperation, exchange of views, experience and knowledge in regard to all matters connected with the testing of materials and contributing toward the solution of relevant problems. The principal means of securing these results is to be the holding of periodical international congresses at intervals of not less than three or more than five years, preferably at three-year intervals. The formulation of standards is outside the scope of the Association but giving technical advice regarding standardization to approved standardizing bodies is within its scope.

Art. 3.—Membership of the Association shall be open to the National Associations for Testing Materials or equivalent organizations in the associated countries.

Art. 4.—The Association shall be governed by a Permanent Committee consisting of one member from each National Association adhering to the Association. Each member of the Permanent Committee shall be elected by his National Association or in the absence of a National Association, by the equivalent organization in that country.

Art. 5.—The Permanent Committee shall at each meeting invite the representative of the country in which the meeting is held to act as chairman of the meeting.

Art. 6.—The Permanent Committee shall appoint an Honorary Secretary, if possible the member representing the country where the next Congress is to be held; alternatively, he may be an additional delegate to the Committee nominated by that country. The Honorary Secretary shall carry on the business of the Association at and between the meetings of the Permanent Committee.

Art. 7.—The Permanent Committee shall hold at least one meeting in every year; these meetings shall be convened by the Honorary Secretary who shall be also empowered to call such additional meetings as appear necessary; extra meetings shall also be called at the request of representatives of not less than four countries. The Permanent Committee shall also meet at the time of each Congress.

Art. 8.—At the meeting of the Permanent Committee held at the time of each Congress, the country and the year in which the next Congress shall take place shall be designated and general decisions taken regarding the scope and program of that Congress. The National Association or equivalent organization of the country designated to hold the next Congress shall take over entirely the responsibility for the arrangement, organization and finance of that Congress, in addition to the publication of the Congress Book.

Art. 9.—The languages of all associated countries are to be regarded as official languages at Congresses.

At its January meeting, the A.S.T.M. Executive Committee decided to adhere to the I.A.T.M. as the American national testing society and took action to appoint the Secretary-Treasurer, C. L. Warwick, as the A.S.T.M. representative on the Permanent Committee. Since meetings of the Committee are held usually in some European city, it was felt desirable to appoint an alternate who would be in a position to attend meetings of the Committee. Accordingly, W. L. Cooper, Director of Foreign Operations, Robert W. Hunt Co., who is in Europe several months each year has accepted appointment as Mr. Warwick's alternate.

At the London Congress an invitation extended by Professor Dr. Ing. P. Goerens (Vice-President, Germany), on behalf of the Deutscher Verband für die Materialprüfungen der Technik for the next Congress to be held in Germany, probably in 1940, was accepted. Professor Goerens was unanimously nominated President of I.A.T.M. to serve until the end of the next Congress. Dr. M. Moser, Dorotheenstrasse 40, Berlin, N.W. 7, has been selected as I.A.T.M. secretary.

A Method of Evaluating Concrete Data by Correlation

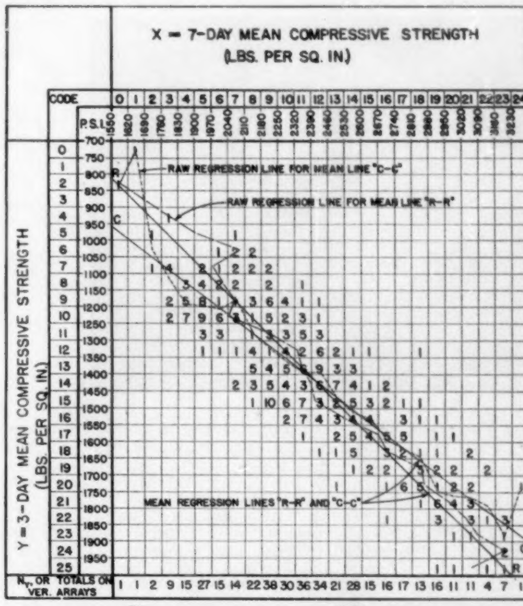
by H. W. Leavitt[1]

Applied statistical methods have been extensively used for some time in the fields of education, biology, economics, etc., and their use is rapidly increasing in industry and engineering.

Many articles, both in the publications of the Society[2] and elsewhere, and also many texts, have been published on the subject of applied statistics. In most of the literature, however, the engineering application of the statistical analysis method has been confined to the distribution or frequency of one set of variables instead of the more complicated comparison of two sets of related variables.

This paper presents in as simplified a form as possible the statistical solution of a correlation table prepared to show the inter-relation between the 3-day and the 7-day compressive strengths of 2-in. plastic mortar cubes. These data are an outgrowth of the report on "A Study of Plastic Mortar Cubes"[3] sponsored by the Subcommittee XI on Evaluation of Data of the A.S.T.M. Committee C-9 on Concrete and Concrete Aggregates. While the data relate to concrete materials, the method of solution might apply equally well to other groups of data. In the interest of simplification and for the convenience of those who have had little occasion to use the statistical method, certain refinements in the nomenclature and the symbols commonly employed by statisticians have been used in this report.

The data assembled give a clear conception of the relation between 3-day and 7-day compressive strengths of 2-in. plastic mortar cubes. The data for the correlation table[4] (Fig. 1) were obtained from a series of compression tests on cubes of plastic mortar made in accordance with the



Y code	I. N_X, or totals on hor. arrays	II. ΣX, or summation of mom. on X-axis	III. ΣX^2, or summation of second mom. on X-axis	IV. ΣXY, or prod.-mom.	V. ΣY, or summation of mom. on Y-axis	VI. ΣY^2, or summation of second mom. on Y-axis
0	1	1	1	0	0	0
2	1	0	0	0	2	4
4	1	3	9	12	4	16
5	2	9	53	45	10	50
6	5	36	262	216	30	180
7	14	78	514	546	98	686
8	14	87	601	696	112	896
9	32	220	1726	1980	288	2592
10	39	254	1894	2540	390	3900
11	21	189	1827	2079	231	2541
12	25	266	3036	3192	300	3600
13	35	381	4261	4953	455	5915
14	37	422	5026	5908	518	7252
15	41	479	5871	7185	615	9225
16	29	388	5366	6208	464	7424
17	24	371	5825	6307	408	6936
18	16	256	4206	4608	288	5184
19	14	252	4620	4788	266	5054
20	19	346	6398	6920	380	7600
21	14	275	5413	5775	294	6174
22	11	227	4733	4994	242	5324
23	3	64	1370	1472	69	1587
24	2	46	1058	1104	48	1152
25	4	84	1774	2100	100	2500
Totals	404	4734	65844	73628	5612	85792

EQ. 1. $\text{MEAN } X = \frac{\Sigma X}{N}(\text{CLASS INTERVAL}) + (\text{ORIGIN}) = \frac{4734}{404} \times 70 + 1585 = 2405.2475$

EQ. 2. $\text{S.D.}_x = \sqrt{\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2}(\text{CLASS INTERVAL}) = \sqrt{\frac{65844}{404} - \left(\frac{4734}{404}\right)^2} \times 70 = 354.6787$

EQ. 3. $\text{MEAN } Y = \frac{\Sigma Y}{N}(\text{CLASS INTERVAL}) + (\text{ORIGIN}) = \frac{5612}{404} \times 50 + 725 = 1419.5545$

EQ. 4. $\text{S.D.} = \sqrt{\frac{\Sigma Y^2}{N} - \left(\frac{\Sigma Y}{N}\right)^2}(\text{CLASS INTERVAL}) = \sqrt{\frac{85792}{404} - \left(\frac{5612}{404}\right)^2} \times 50 = 220.1936$

EQ. 5. "r", THE COEFFICIENT OF CORRELATION,

$$= \frac{\frac{\Sigma XY}{N} - \frac{\Sigma X}{N}\cdot\frac{\Sigma Y}{N}}{\sqrt{\left[\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2\right]\left[\frac{\Sigma Y^2}{N} - \left(\frac{\Sigma Y}{N}\right)^2\right]}} = \frac{\frac{73628}{404} - \frac{4734}{404}\cdot\frac{5612}{404}}{\sqrt{\left[\frac{65844}{404} - \left(\frac{4734}{404}\right)^2\right]\left[\frac{85792}{404} - \left(\frac{5612}{404}\right)^2\right]}} = 0.8727 \pm 0.008$$

Fig. 1—Correlation Table Showing the Relationship Between the 3-day Mean Compressive Strength and the 7-day Mean Compressive Strength of Plastic Mortar Cubes

A.S.T.M. Tentative Method of Test for Compressive Strength of Portland-Cement Mortars (C 109 – 34 T).[5]

Two variables are represented: the 7-day compressive strengths (each the mean result of three cubes made on the same day) as variable No. 1 plotted on the *X*-axis, or in *horizontal arrays,* and the 3-day compressive strengths (each the mean result of three cubes made on the same day) as variable No. 2 plotted on the *Y*-axis, or in *vertical arrays.* The origin of the table is at the center of the upper left-hand space. It will be noted that each row, or horizontal array, in this table gives the frequency distribution of the first variable for cases in which the second variable lies within the limits stated at the left of the row, or *horizontal array.* To illustrate, the upper horizontal row contains as its first entry, "1," in the "1620" column. This entry represents a single day's results (six cubes), three of which tested between 700 and 750 lb. per sq. in. at the 3-day age, and three between 1620 and 1690, at seven days. Similarly, every column gives the frequency distribution of the second variable for cases in which the value of the first variable lies within the limits stated at the head of the column. Yule[6] uses the word *array* to denote either a column or a

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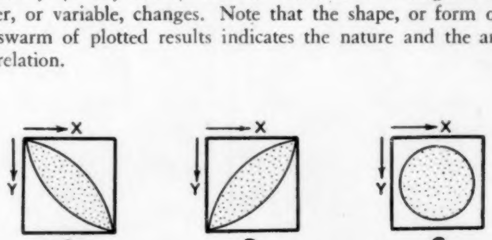
[1] Secretary, Maine Technology Experiment Station, University of Maine, Orono, Maine.

[2] Notably the 1933 A.S.T.M. Manual on Presentation of Data, *Proceedings,* Am. Soc. Testing Mats., Vol. 33, Part I, p. 451 (1933), also published in separate pamphlet form.

[3] *Proceedings,* Am. Soc. Testing Mats., Vol. 37, Part I, p. 321 (1937).

[4] *A Correlation Table,* or *Scatter Diagram,* is a plotted record of the frequency distributions of two different characters so arranged as to show the tendency (if any exists) for one character to change as the other character, or variable, changes. Note that the shape, or form of scatter, of the swarm of plotted results indicates the nature and the amount of the correlation.



Example A: Shows a case of *positive correlation* (when character, or variable, *X* increases, the corresponding character Y also increases).

Example B: Shows a case of *negative correlation* (when character *X* increases, Y decreases in value).

Example C: Shows a case of *zero,* or no *correlation* (when variable *X* increases, Y may increase or decrease).

[5] *Proceedings,* Am. Soc. Testing Mats., Vol. 34, Part I, p. 743; also 1934 Book of A.S.T.M. Tentative Standards, p. 297.

[6] G. U. Yule, *"An Introduction to the Theory of Statistics,"* Griffin & Co., Ltd., London (1916).

row (vertical or horizontal alignment). The arrangement of data as shown above is called a *correlation table.*

Figure 2 illustrates a model diagram of Fig. 1. This

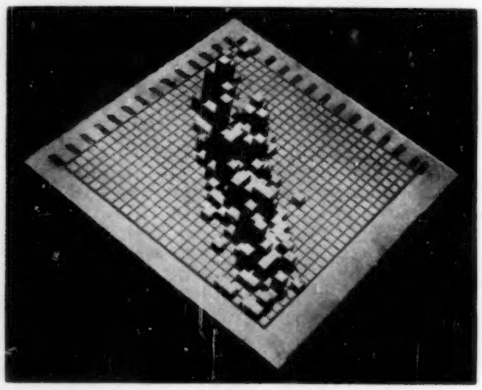


Fig. 2—Model Diagram, or *Stereogram,* Giving a Solid Representation of the Data in the Correlation Table of Fig. 1

type of diagram gives a solid representation of the data. Such models are sometimes termed *stereograms.* The frequency surface is seen to be irregular, but with a definite trend to a general shape. If the compartments were gradually decreased in size, and their number increased to infinity, the irregular figure obtained by joining the tops of each of the vertical columns would more nearly approximate a continuous curved surface. Again, if a greater number of tests had been made (only 404 pairs of means, or 2424 cubes, are represented), much of the apparent unevenness of the surfaces would have been smoothed out. The construction of stereograms on increasing numbers of specimens, or *individuals,* gives a good method of illustrating the importance of adequate data—the added value of large numbers of tests.

As the numbers of test results are increased, the total frequency curve approaches a smooth curve. Figure 3 shows a plot of the N_x and N_y, or class frequencies, on the X- and Y-axes. The ragged lines are the actual frequencies as found in this series of 404 sets of means. The theoretical frequency curves[7] are the smooth curves shown for both the X and Y frequencies. Here again is emphasized the great importance of large numbers.

In order to clarify the meaning of the statistical constants derived from a simple correlation table like that shown in Fig. 1, a detailed solution is presented. Several different methods are used in solving tables of data of this kind, but the one described is believed to be the easiest for machine calculation.

The origin is located in the upper left-hand corner of the table, and the numbers are treated as a system of weighted forces, and their lever arms are used to secure their first and second moments, both horizontally and vertically, about the point of origin. Most tables of this type are coded so that approximately 20 to 30 rows and columns are obtained. The point of origin need not be at the zero value of the coded variable. In this table, for instance, the actual origin is located half way in the "0" space on the X-axis (7-day compressive strength of 1585 lb. per sq. in.). On the vertical axis, the actual origin is at 725 lb. per sq. in. The figures in each horizontal row are totaled and entered in column I, labeled N_x; likewise figures in each column are entered in the "total" row at the base of the table, labeled N_y. Then $\Sigma N_x = \Sigma N_y$. In this table the summation, 404, is the number of daily batches studied.

Five laboratories made 60 daily batches each, one made 59, and another made only 45 for this particular study. Each one of these entries represents the average of three cubes broken at the age of 3 days which was plotted with the average value of three more cubes made from the same batch but broken at the age of 7 days. For example, figure "1" in the top array is located in the horizontal code

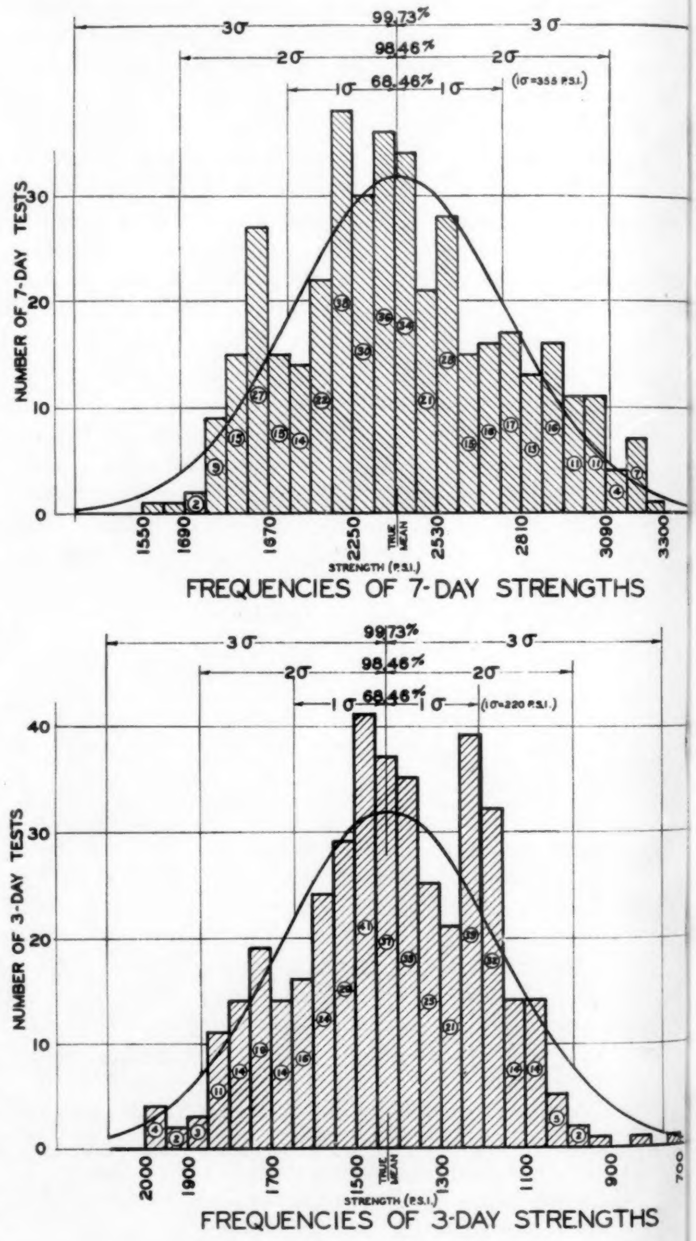


Fig. 3—Diagrams Showing Actual Frequencies and Theoretical Frequency Curves for the 7-day and 3-day Mean Compressive Strengths Presented in Fig. 1

[7] See p. 17 for further discussion of the normal curve.

space "1", and in the vertical code space "0." If interpreted in terms of actual pounds per square inch of compressive strength, it is seen to have a value of 725 lb. per sq. in. at 3 days, and 1655 at the 7-day age. It must be remembered that this single figure represents considerable laboratory work since it was compiled from the data on six cubes. The entire entries represent 2424 2-in. cubes.

The quantities in column II, "ΣX", are the summation of moments of the data on the X-axis. To illustrate, consider the sixth horizontal array which is code space "5" containing only two entries. ΣX for this array is obtained by a summation of the first moments of numbers located in this array obtained by multiplying each entry number by its lever arm. The grand total for ΣX is 4734.

Column III gives values of ΣX^2, the summation of the second moments on the X-axis. For the sixth horizontal array we find the entry is 53. This is obtained by multiplying each entry by the square of its moment arm. The grand total is 65,844.

Column IV gives the summations of the values of ΣX multiplied by the vertical moment arm, or code spaces. For the sixth row, the *product moment* (ΣXY) $=$ 45 or 9 times 5. The next value, 216, was obtained by taking the ΣX value and multiplying by its lever arm, 6. The grand total is 73,628.

Column V gives values for the first moments on the vertical or Y-axis. As entered in the table, the values are obtained from the products of the totals, N_x (Column 1) and their lever arms, taken vertically from the origin. The grand total is seen to be 5612.

Column VI gives the values of ΣY^2, or the summation of the second moments on the vertical, or Y-axis. These values are obtained in the same way as those for the previous column except the code value, or moment arm, is squared for each computation. The grand total for this column is 85,792.

The totals for columns I to VI give all data necessary for the solution of the correlation table. The next steps are to determine the true means, the true standard deviations, the correlation coefficient, and the prediction equations.

MEANS

The mean results for the two variables, X and Y, are determined by use of Eqs. 1 and 3 (see Fig. 1). Mean $X =$ 2405.25 lb. per sq. in. which is the average compressive strength of the 404 sets of 2-in. cubes when tested at the age of 7 days.

The mean for the other variable (3-day compressive strength) on the Y-axis is obtained in a similar manner from Eq. 3 and mean $Y = 1419.5$ lb. per sq. in.

STANDARD DEVIATIONS

The standard deviations[8] are obtained by use of Eqs. *2*[9] and *4* (see Fig. 1).

$\text{S.D.}_x = 354.68$ lb. per sq. in., and $\text{S.D.}_y = 220.19$ lb. per sq. in.

The *standard deviation*, σ, gives very important information about the data being studied as a group. Some of its most important characteristics are as follows:

1. It is affected by the value of every item or deviation.

2. Greater emphasis is placed on extreme variations than in the case of the common mean deviation, since all deviation values are squared in the computation of σ.

3. In a normal or bell-shaped distribution (see Fig. 3) the probable error, or quartile deviation, is 0.67449 σ. In skewed distributions, this condition holds only in cases of moderate skewness.

4. A distance of σ measured on the horizontal axis on both sides of the arithmetic mean of a normal distribution will include 68.26 per cent of all the items or test values; 2 σ will include 95.46 per cent and 3 σ will include 99.73 per cent of all the cases represented.

5. Since three standard deviations on each side of the mean include all (99.7 per cent) of the cases in normal or moderately skewed frequencies, the value σ may be considered to represent about one-sixth of the total range. In the case of the X-variable (7-day compression) considered above, this estimate is over-conservative, as 6 times 354.68 $=$ 2128.08, the estimated total range of this series of tests, whereas the actual range from highest to lowest value of the 404 cases was only 1750 lb. per sq. in. Thus, the distribution is not perfectly normal, since deviations of extremes were found less frequently than expected.

Equation 4 gives a solution, similar to Eq. 2, for the Y-variable or results on corresponding 3-day test specimens. The standard deviation for the 404 sets of cubes tested in compression at the age of three days was found by Eq. 4 to be 220.19 lb. per sq. in.

THE CORRELATION COEFFICIENT

The correlation coefficient, r,[10] is determined and used as a quantitative measure of the relationship between two series of data on two variables. It is a pure number, and as such may be compared from correlation table to correlation table. In the present case, the variables are the 404 3-day tests and their corresponding 7-day tests. It is desired to know (quantitatively) whether this relationship is good or bad. The correlation coefficient r ranges in value from $+1$ through 0 to -1. Its magnitude is unaffected by the scales

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[8] The *Standard Deviation*, a very common term in all statistical quantitative analyses, is the square root of the average of the squares of all deviations, such deviations being measured from the average observations. The standard deviation may be defined as the root-mean-square deviation from the average. The most common formula for standard deviation is:

$$\sigma = \sqrt{\frac{\Sigma (X)^2}{N - 1}}$$

where $\sigma =$ standard deviation,
$X =$ deviations from the average, and
$N =$ total number of items.

(See *An Outline of Statistical Methods*, by Arkin and Colton, published by Barnes & Noble, Inc., 105 Fifth Ave., New York, p. 34.) As encountered in engineering computations, the standard deviation is known as "the radius of gyration." Other names applied to this constant are "mean error" (Gauss), "error of mean square" (Airy), and "mean square error." The term standard deviation was first proposed by Prof. Karl Pearson in 1893. (Also see Walker, Helen M., Ph.D., *Studies in the History of Statistical Method*, published by the Williams & Wilkins Co., Baltimore, 1929, pp. 1-229 and special citation on p. 188.) In the present paper, the *standard deviation* will be designated by the symbols S.D. or (σ).

[9] In Fig. 1, for convenience in machine calculation, the origin through which the axes pass is chosen to be at the center of the upper left-hand square. In Eq. 2 the second term under the radical, $\left(\frac{\Sigma X}{N}\right)^2$ has the effect of transferring the origin from this position to the position of the means of the data as plotted in Fig. 1.

in which X and Y are measured, for these scales will affect both the numerator and the denominator of Eq. 5 to the same extent. If the two variables are independent, the value of r is 0. If completely dependent, the value of the coefficient will be 1.0. In linear correlation (straight lines give best fitting regression lines), the change in one variable is at a constant ratio to the other. This constant ratio, when it indicates that an increase in the value of one of the variables is accompanied by an increase in the other, is called *direct* or *positive* correlation. In cases of positive correlation, therefore, the values for r are always plus, and the correlation coefficient ranges in value from 0 to $+1.0$. When the ratio indicates that an increase in one variable means a decrease in the other, the results are called *inverse* or negative *correlation.* In cases of inverse correlation the values for r are negative, and the correlation coefficient ranges from 0 to -1.0.

Equation for Correlation Coefficient, r:

Equation 5 (Fig. 1) gives the solution for r, the correlation coefficient.

Numerical substitution gives a value of $r = 0.873 \pm 0.008$.

This value of r is significantly high[11] and direct, meaning that an increase in the compressive strength of a 3-day cube is a very good indication that the corresponding 7-day compressive strength will also increase an expected amount; high results of one test indicate high results in the other test and vice versa.

The value, $\pm$ 0.008, is known as the probable error, and is obtained from the expression, $0.67449 \dfrac{(1 - r^2)}{\sqrt{N}}$. This value (0.008) gives the probable range in the value of the coefficient.

The real significance of the correlation coefficient is understood when expressed as a per cent of control.

Per cent control $= 100 \ (1 - \sqrt{1 - r^2})$.

For this coefficient the *per cent control* is found to be 51.2 per cent. This means that if one has obtained a mean or average of a 3-day result (average of 3 cubes) the prediction of a corresponding 7-day result may be made with a probable range of error which is only 48.8 per cent of the possible range of the 404 series of tests given in Fig. 1. Therefore, the range of variability is under 51.2 per cent. control.

THE PREDICTION EQUATIONS

The prediction equations, or, as generally called, "regression equations," have been consistently used by Pearson, Yule, and others in connection with the lines of mean arrays in scatter diagrams. In Fig. 1, the *regression* lines are the straight lines labeled RR and CC running diagonally through the diagram. These particular lines are seen to be straight, although in some cases of correlation the lines are curved. The actual means of each array on the X-axis are connected by a broken line. The line RR defines very closely the trend, or slope, of this broken line. The line CC defines the *line of best fit* for the means of arrays on the Y-axis. Here again, it is seen that the straight line CC depicts the trend of the actual 3-day values (Y-variables) with respect to the actual 7-day results (X-variables). These two lines are, therefore, the lines of best fit to the actual *raw regression lines* which pass through the actual means of each array. Other terms, and ones possibly more connotative of the actual functions of such lines as RR and CC, might be *characteristic lines,* or *lines of trend.*

The plotting of the regression lines gives a check on the arithmetical work for the solution of the correlation table. *These lines must intersect at the means of the two variables.* This intersection point for Fig. 1 is found at the location, $X = 2405.2$, $Y = 1419.5$.

The equations for the regression lines are valuable for prediction purposes. Equations 6 and 7 give the formulas for determining the *prediction equations* of lines RR and CC:

$$\text{Eq. 6.} \quad X = \text{Mean } X - \frac{SD_x}{SD_y} r \text{ mean } Y + r \frac{SD_x}{SD_y} Y.$$

$$\text{Eq. 7.} \quad Y = \text{Mean } Y - \frac{SD_y}{SD_x} r \text{ mean } X + r \frac{SD_y}{SD_x} X.$$

In order to translate the meaning of *prediction equations* 6 and 7 into terms of Fig. 1, the symbols X and Y should be interpreted as 7-day compressive strength and 3-day compressive strength, respectively.

Numerical substitution of data from Fig. 1 into Eqs. 6 and 7, give the following prediction equations, 8 and 9.

Eq. 8. Predicted 7-day compressive strength $= 1.406$ (3-day compressive strength) $+ 409$.

Eq. 9. Predicted 3-day compressive strength $= 0.542$ (7-day compressive strength) $+ 115.98$.

Only Eq. 8 is of practical significance since the 3-day information will be obtained before the 7-day results, and the latter will be the value usually desired by such a prediction.

Several methods of solving a correlation table, other than the one described above, are in general use. This particular method is recommended because of the facility of solution when a calculating machine is available. In addition to obtaining such terms as *means, standard deviations, correlation coefficient,* and prediction equations, or lines of *best-fit,* there

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[10] The term "correlation" was first used in a statistical sense in a paper by Sir Francis Galton in 1888. In 1877 he had designated the slope of his regression lines as "*r*" for reversion, and in 1888 he again used the coefficient "*r*," which then stood for regression. W. F. R. Weldon used the symbol "*r*" in 1893 and designated it as "Galton's function." The term "*Coefficient of Correlation*" was probably first used by Edgeworth in 1892. Prof. Karl Pearson was the first to use the "product-moment" method of correlation. His first publication on correlation came out in 1893 and the coefficient "*r*" is sometimes called the "Pearson Coefficient." For further historical data read "*Studies in the History of Statistical Method,*" by Helen M. Walker, Ph.D.

[11] According to W. I. King, "*The Elements of Statistical Method,*" p. 215, MacMillan & Co., New York City (1921), "The following rules will assist in giving a general idea of the interpretation of *r* according to its relation to its probable error:

1. If *r* is less than the probable error, there is no evidence whatever of correlation between the two variables studied.
2. If *r* is more than six times the size of the probable error, the existence of correlation is a practical certainty. There might be added to the above the further statements that, in those cases in which the probable error is relatively small,
   1. If *r* is less than 0.30, the correlation cannot be considered at all marked.
   2. If *r* is above 0.50, there is decided correlation."

Also, see Fisher, R. A., *Statistical Methods for Research Workers,* Oliver and Boyd, London, 1930, 3rd Ed., p. 176; and Wallace and Snedecor, *Correlation and Machine Calculation,* Iowa State College, Ames, Iowa, 1931, pp. 62-63, for tables of significant values.

is provided a graphic picture of the data. Often the segregations, or groupings, of data in clusters, as found in such pictures, offer possibilities for further study. Such groupings might not be recognized otherwise.

As to the importance of the correlation coefficient, Dr. R. A. Fisher states:[12]

> "No quantity is more characteristic of modern statistical work than the correlation coefficient, and no method has been applied successfully to such various data as the method of correlation. Observational data, in particular, in cases where we can observe the occurrence of various possible contributing causes of a phenomenon, but cannot control them, has been given by its means an altogether new importance."

Correlation is a very useful, if not essential, tool for the testing engineer and research worker on engineering materials. It should be understood, however, that statistical mathematics is useful only when clearly understood and properly applied. Improperly applied or blindly followed, the method may be formally correct but lead to quite wrong conclusions.

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[12] R. A. Fisher, "Statistical Methods for Research Workers," Third edition, p. 140, Oliver and Boyd, London (1930).

Citation for Membership Work

As previously indicated, the past year, with 441 new members elected, resulting in a net growth of 261, the largest in ten years, was an exceptionally encouraging year from the standpoint of A.S.T.M. membership growth. To point out a single factor responsible for this is obviously difficult. There were a number of factors, including increased industrial activity, the extension of the Society's work into new fields, but primarily the very successful year resulted from personal work and interest on the part of our present members. In a majority of the cases, it was the activity of present members which resulted in inducing a company or individual who would profit from Society affiliation to join with it.

A very large number of members have assisted in various ways in obtaining new members. Because of the outstanding interest of certain men in membership work, the Executive Committee wishes to make special mention of the following members whose names during 1937 have appeared on three or more new members' application blanks.

C. E. Ambelang	Alfred Herz
H. J. Ball	C. E. Heussner
F. E. Bash	H. S. Mattimore
E. W. Bauman	F. F. Miller
A. L. Chapman	J. R. Townsend
H. F. Clemmer	H. P. Trevithick
R. W. Crum	E. W. Upham
E. H. Davidson	W. H. Whitcomb
E. R. Young	

Of these men, Messrs. Ball, Heussner, Trevithick, Upham, and Whitcomb also were listed in the group cited for membership interest for the previous year. It is of interest also that of the group Messrs. Bash, Heussner and Whitcomb had a part in applications received from seven or more new members.

Many other active members have rendered important service to the Society in membership promotional work, not only in obtaining new members, but in following up invitations which have been extended.

Our goal is 4400 members by 1939 and to reach this, 1937 records will have to be bettered. This means increased activity all along the line. One of the factors which always impresses is the fact that there are hundreds of companies concerned with engineering materials and large groups of technologists who would benefit for membership. The problem is to get the man and the idea of membership properly together. In the attainment of the 1939 goal, every member can render important service.

Rubber Conference in London

Under the auspices of The Institution of the Rubber Industry there is being held in London from May 23 to 25 inclusive, a Rubber Technology Conference. Its purpose is to bring together a representative gathering of rubber technologists from overseas. American participation in the Conference is being arranged through a committee appointed by the Rubber Division of the American Chemical Society. A.S.T.M. has been invited to participate and Dr. A. A. Somerville, Vice-President, R. T. Vanderbilt Co., Inc., New York City, a member of Committee D-11 on Rubber Products, will serve as official A.S.T.M. representative.

The program is being developed in two divisions, the first covering Methods of Improving and Evaluating the Durability of Rubber, the second, on General Subjects. Topics under the former include: Manufacturing Conditions, including Compounding; Uses of Synthetic Rubbers and Allied Plastics; Testing Methods. General Subjects will cover Chemistry and Physics of Latex and Rubber, also Technology; Rubber Derivatives and their Uses; Raw Materials; Manufacture of Particular Goods; Machinery and Appliances; Organization and Administration.

W. F. B. Cox, 12 Whitehall, London, S.W.1, England, is Secretary of the British Institution.

Engineering Congress in Glasgow

An International Engineering Congress will be sponsored in Glasgow, Scotland, June 21 to 24, inclusive, by a number of engineering societies. This will be held during the progress of the Empire Exhibition. The Society has been invited to appoint two official delegates and an invitation to Congress membership has been extended to any members of the Society by the committee in charge. A fee of £2 5s. will be payable by each member and £1 15s. for an accompanying lady. These fees will include: Attendance at Congress, excursions, receptions, etc., admission to the Exhibition, and volume of proceedings for each member.

A detailed program, including several technical sessions, is being prepared and together with other necessary details will be announced. Members who may be planning to attend the Congress can obtain further details by writing P. W. Thomas, Honorary General Secretary, 39 Elmbank Crescent, Glasgow, C.2, Scotland.

ASTM BULLETIN

Published by

AMERICAN SOCIETY FOR TESTING MATERIALS

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No. 91   **March, 1938**

Amazed

One of the members who was attending committee meetings for the first time in Rochester stated: "I am amazed by the great amount of work transacted at these committee meetings and by the earnestness of the hard-working committee members. I never realized so much went on behind the scenes." Even better than the annual meeting where committee meetings are worked around the numerous technical sessions, Committee Week, devoted entirely to meetings of the committees, gives a pretty clear picture of how A.S.T.M. is meeting the need for standardization and research work in the field of engineering materials.

The immense amount of work accomplished by committees and the loyalty of committee officers and the members which make this possible, has been commented on time and again. It is this emphasis on *work* which has given the Society the important place it occupies from the standpoint of industry, and further, that makes membership in the Society of great value—a value that is constantly appreciating with time regardless of up and down fluctuations which may be occurring in business, in government, and elsewhere.

Every member at some time during his period of affiliation with the Society should make a real effort to attend an annual meeting or regional meeting, if for no other reason than to see just how the work of the Society is carried forward.

The Importance of Little Things

Returning from Committee Week in Rochester after attending numerous meetings of groups working in diversified fields, we naturally have a variety of impressions on different subjects. There is one, however, which is not difficult to place in its niche—namely, the importance of little things in the standardization of specifications and methods of testing.

Anyone who was attending the series of committee meetings for the first time might gain the impression that considerable time and energy were wasted in discussing things relatively insignificant, but a careful analysis would indicate that by and large even the seemingly most minor item might be of tremendous significance from either the standpoint of production or consumption or both.

A small variation in chemical composition or a slight change in procedure specified for testing or in the instruments used in carrying out tests may be of utmost importance.

Just one example of what we have in mind: A piece of glassware used in one of the tests had specified a tolerance which was closer than was needed and with a slight variation only a few hundredths of a milliliter, the glassware could be supplied from standard lines instead of from special stock.

Especially in publishing specifications and test procedures are small things of utmost importance and constant checking and rechecking is necessary to insure errorless reproduction of standards which may govern the purchase of materials involving large sums of money.

The importance of little things in standardization was the subject of the presidential address in 1926 and occasionally when seemingly insignificant items may seem to be assuming a place out of all proportion, a review of this address is worthwhile.

Papers Sponsored by Committees

The Ninth Regional Meeting of the Society has just closed. It was sponsored by a group of loyal Rochester A.S.T.M. workers who assisted the staff in working out the program for the week's activities. It was one of the largest meetings which has yet been held, with a registration of 660 for the week. Approximately 165 committee meetings took place during the week, an amazing number even to some of us who have been seeped in Society work for a number of years.

Of broad general interest was the Symposium on Plastics attended by between 450 and 500 at which six technical papers were presented.

The banquet on Wednesday evening was unusually successful. It was attended by approximately 235, who listened to a noteworthy address given by Dr. Brian O'Brien of the University of Rochester on "Balloon Exploration of the Upper Atmosphere."

The general interest shown at these sessions as well as the interest evidenced at all of the former technical meetings of the Society lead one to the conclusion that the members of the Society as well as technical men at large are hungry for papers giving the results of scientific work whether their presentation be through the agency of symposiums or in general technical sessions.

This is a field of activity in which our Standing Committees can be of great service to the Society, and I should like to urge that, in so far as possible, they sponsor the presentation of papers dealing with the results of investigation in their respective fields through channels such as are available at the Annual, Regional and District meetings, as well as through space in the Bulletin.

This would prove of assistance to those charged with the preparation of programs, it would aid greatly in increasing the interest in general sessions and would be the means of adding materially to our store of technical knowledge.

A. E. White
President

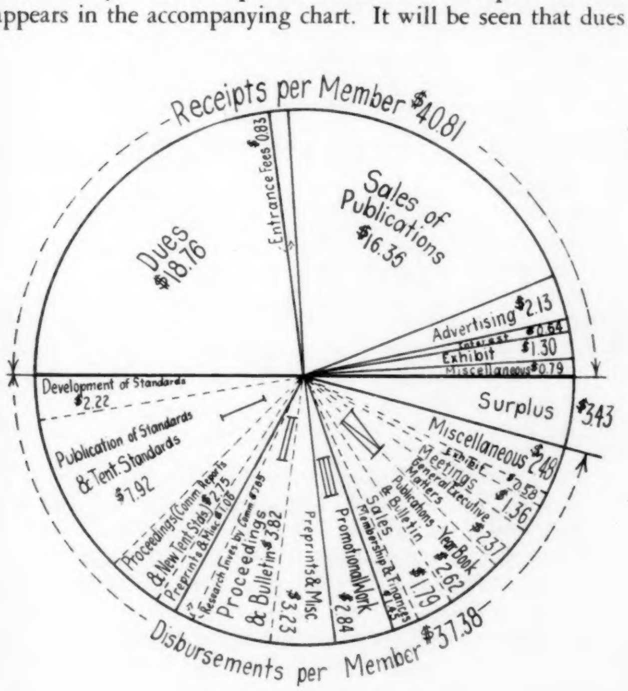
Notes on Society Finances

The following notes from the Secretary-Treasurer's report to the Executive Committee in January on finances contain some interesting facts.

Total receipts for 1937 were $166,512—largest in our history—comprising $79,924 from dues and entrance fees, $66,768 from sales of publications and $19,820 from advertising, exhibit, interest and miscellaneous sources. Publications sales exceeded all previous figures, and reflect the ever growing demand for Society standards and various special publications. Increased income from this source has more than offset the lessened income from dues compared to 1930 figures, but at that the income from membership dues is steadily increasing. Advertising showed considerable increase over 1936 figures, and the exhibit was also financially successful.

Disbursements for the year totaled $152,527, which includes $6,000 reserve toward the cost of the 1939 Book of Standards. A favorable balance between receipts and disbursements of $13,985 has accordingly resulted.

An analysis of receipts and disbursements per member appears in the accompanying chart. It will be seen that dues



represent just under half of all receipts, with publications sales at 40 per cent of the total. Disbursements are classified into the following four groups, with per member amounts as follows:

I. Standardization—Development and Promulgation	$13.95
II. Advancing Knowledge of Materials	7.94
III. Promotional Work	2.84
IV. Administrative Work	12.65
	$37.38

That the Society could not, on dues income alone, serve its members and the technical and industrial groups from which they come nearly so effectively as it does, is obvious from these figures. The growing income from publications sales enables the Society to carry on its work more intensively and to extend it into new fields more rapidly than would otherwise be possible, and this in turn increases the value of the Society to its members and to industry generally.

The budget for 1938 provides for disbursements of $148,000. Current receipts are conservatively estimated at about $139,000, which will be supplemented by $9,000 from the 1937 surplus. This latter amount includes profits from the exhibit which it is the policy to spread over two years, and the non-recurrent item of sales of the Book of Standards above normal in the year immediately following its publication—the latter, about $6,000, being applied to reserve for the 1939 edition.

The budget provides for the usual Society activities, including all regular and a number of special publications, and expansion of the BULLETIN. The effect of the unsettled business conditions is problematical. The budget will be reviewed quarterly and necessary adjustments made to keep expenses within income.

1938 Nominating Committee

After reviewing the report of the tellers, G. A. Reitz, Treasurer, Samuel P. Sadtler and Son, Inc., and C. A. Rossman, Partner, Philadelphia Thermometer Co., on the recommendations of members for appointments on the 1938 Nominating Committee, the Executive Committee at its January meeting selected members of the committee. A meeting of the Nominating Committee was held at A.S.T.M. Headquarters in March with the following present:

W. M. Barr	H. S. Mattimore
A. C. Fieldner	J. C. Pearson
L. H. Fry	H. S. Vassar
Dean Harvey	W. H. Whitcomb

Messrs. Vassar and Fieldner, together with Dr. Hermann von Schrenk, who was not able to be present, were members of the Nominating Committee in accordance with the By-laws which provide that it shall include the three last past-presidents.

Following the customary procedure, the nominees for president, vice-president and five new members of the Executive Committee will be announced in the May BULLETIN.

Carnegie-Illinois Steel Corporation New Sustaining Member

The Carnegie-Illinois Steel Corp. is the latest company to join the list of those who have become sustaining members of the Society, the membership of this corporation having become effective as of January 1, 1938. Mr. C. F. W. Rys, Chief Metallurgical Engineer, will continue to act as the official representative of this membership. This company has held continuous membership in the Society since 1898 when A.S.T.M. was just an American section of the International Association. Various technologists from this company have been extremely active in service on A.S.T.M. technical and administrative committees, and many of the men have attained positions of prominence and responsibility in the Society's affairs.

This class of membership with annual dues of $100 was established so that companies and other organizations wishing to, might support the work of the Society to a degree more nearly commensurate with the intrinsic value to them of the standardization and research activities.

LETTERS TO THE EDITOR

EDITOR'S NOTE.—In his "Letter to the Editor" published in the January BULLETIN (page 21), Dr. H. H. Lester raised an interesting question—namely, to just what extent should our interest lead us into research work of a fundamental nature. Quite a number of A.S.T.M. members have submitted comments on the questions raised by Doctor Lester and there are published below letters from four active and long-time members. Further discussion of this question will be welcomed.

A.S.T.M. in Basic Research?

THE discussion of the extent to which the Society should engage in research and the general nature of such research is one which should command wide and serious consideration in the Society. The presentation of the subject by Doctor Lester should appeal to many Society members, certainly to all who have an active interest in committee work. One does not have to be a member of any technical committee of the Society long to be impressed greatly by the large amount of investigative work necessary for any committee to function properly and effectively. Such investigative work may be planned as a long-range program to cover several decades as in the exposure programs of Committees A-5 and B-3 or it may consist in the determinations of certain basic properties, a knowledge of which is necessary to the formulation of a specification as, for example, a method for determining the grain size of steels or the strength of paint films. Whether we designate such research, "fundamental" or not, is largely a matter of definition. Certainly it does not conform to the notion many of us have concerning "fundamental research." To many of us, this term implies complete freedom on the part of the investigator as to the particular line to be followed, the method to be employed and, what is most important of all, complete freedom from any pressure whatsoever to give the work or its findings some practical application.

The need for first-hand information to fill in the blanks which are so obvious in any tabulation of the essential properties of practically every engineering material is so pressing that many years' investigative work will be required for the acquiring of such information. It is the feeling of the writer that, even if conditions permitted otherwise, the aims of the Society would be best served and greater progress made in advancing our knowledge of engineering materials and their testing, by research work of the "applied" type than by research of a more fundamental nature but pointing to no particular objective. Since the greater part of the investigative work of the Society, by far, is possible only by the cooperation and help of industry, the needs of these cooperators must of necessity always play a very important part in the decision as to the type of work to be conducted.

H. S. RAWDON

National Bureau of Standards,
Washington, D. C.
February 4, 1938

THE letter from Doctor Lester is very suggestive and I have no thought of saying anything that may be contrary to his points of view. With the idea that his proposal should receive some discussion, I am offering the following: While our Society is interested primarily in the testing of materials, my own thought is that there should be no limit, real or imaginary, to the scope of the Society. In testing material, all knowledge relating to materials is of value. Sometimes information obtained in regard to materials may appear at the moment to be of little value but later on the value develops. Broadly, I should say that the scope of our Society is all kinds of knowledge of all kinds of materials under all kinds of conditions. Physically, of course, strength becomes the important thing. Then we must consider strength in relation to all the variations to which a material may be exposed. This involves its relations to other materials, to differences of temperature, and to differences in atmospheric pressure. Thinking only of strength, we therefore must think of it in relation to everything in which it comes in contact which may affect its strength not merely for the moment but considering the time factor. I mention this view merely as an example and to illustrate that when we come to materials, their strength and all their other qualities properly should be recognized as relative, relative under certain standard conditions in the beginning and after, relative to any conditions which may develop. Therefore, we should speak in relative terms stating our conditions precisely and trying to generalize only when it can be done with definiteness and with proper limitations.

Doctor Lester says, "Production-minded executives cannot, except in broad outline, tell scientists what to work on." This is probably true but on the other hand, scientists can and should tell production-minded executives what work should be undertaken. They should use their persuasive powers to get such work approved.

At one time many years ago I laid down the dictum that the research laboratory should be the reflective organ of industry. Perhaps this statement is too broad. What I had in mind is this: The research man should be a thinker. It would be very unwise in any way for an industry to limit such thinking. The real research worker is in a position to see many possibilities of industrial development not ordinarily visible to the strictly business man.

G. W. THOMPSON

National Lead Co.,
Brooklyn, N. Y.
February 7, 1938

DOCTOR LESTER'S letter in the January BULLETIN really demands a definition of "fundamental" or "basic" research, and of what is meant by the "interest" of A.S.T.M., before the topic can be intelligently discussed.

The interests of the members are extremely varied. Through those interests new facts coming to light in the engineering sciences will be brought to bear on the problems that arise in the Society's field of testing. If it should appear that sending a supersonic wave through a specimen might be a quick and reliable way of making an endurance test, it would be quite within the province of the Society, through its Fatigue Research Committee, to try it out, and the Committee should be alert to note whether such a possibility might exist. But till such a situation does arise, I do not see why A.S.T.M. should concern itself with supersonics, or publish information about that branch of science.

There are too many unexplained problems about testing, and what the results of the tests mean in the appraisal of the suitability of materials for engineering use to justify the Society's going into unrelated fields. But the more we know about the mechanism of corrosion, of failure under shock loading, under high temperature, and so on, the better we can devise tests that will truly evaluate.

There is no limit to the depth to which we can properly dig to get at the fundamental truths that we need to know in order to draft a sensible test method or a sound specification. As soon as we see that we need to know it for a practical purpose, search for it becomes applied research, even though it may have to be done with an exhaustiveness, a precision and often at an expense, greater than is common among the devotees of "pure" research. If this hunting for things we need to know is expertly done, so that the facts found are reliable and can be built upon, then the work is "fundamental" research.

I don't care for any definition that draws a hard and fast line

between "applied" and "basic" research. The information unearthed is no less real and valuable when the profit motive actuates the investigators, and they mine deep, than that found by shallow prospecting in new fields merely from intellectual curiosity.

I am personally more interested in research that tries to find the things we know we need to know, and my admiration for A.S.T.M. is largely due to the work its research committees are engaged on in unearthing basic facts—in order to apply them. Doctor Lester's example of the lamp factory which makes "pointed inquiry into the fundamental science involved in illumination" is thoroughly applicable. But the lamp factory hasn't much excuse for studying the behavior of snake venom, important as that may be. The A.S.T.M. should be vitally interested in the facts underlying testing and specifications, no matter how deep it has to dig for them. But it should stick to that field, for there's plenty to do in it.

The A.S.T.M. should be concerned with such problems as why large crane hooks fail under an impact load that a test on a small hook would indicate to be safe, why some alloys fail by intercrystalline cracking under high-temperature loading and others don't, or how to make a corrosion test that will truly evaluate service under a given corrosive condition, but I can't see that it is up to the A.S.T.M. to foster cooperative research into the solubility of gases in copper. It would, however, be quite in order for the A.S.T.M. to foster cooperative investigation of what properties are needed in a bearing metal, and how to evaluate them, or to publish résumés of attempts made to find out these things.

All of which is merely saying that the present policy of the Society in regard to research seems to me to be a sound one.

H. W. GILLETT

Battelle Memorial Institute,
Columbus, Ohio
January 25, 1938

In regard to the question of A.S.T.M. in basic research, it would seem to me that the field of A.S.T.M.'s activities is too widely diversified to make research by the Society practical and at all effective.

Is it not better for each industry to combine for cooperative research in such organizations as United States Institute for Textile Research, Institute of Paper Chemistry, et al?

There are of course also the Mellon Institute and numerous other private research laboratories.

The A.S.T.M. has plenty to do in establishing standard methods for testing.

HORACE J. JAQUITH

Minot, Hooper & Co.,
New York City
January 27, 1938

Committee on Thermal Insulating Materials Organized

Much Interest Shown in Test Work

A NEW committee, designated Committee C-16 on Thermal Insulating Materials, was organized in Rochester during the committee meetings held the week of March 7. This is a culmination of discussions that have taken place over a period of years looking into the desirability of undertaking work in the field of thermal insulation apart from that now being carried out by the Society's Committee C-8 on Refractories. The latter committee includes within its scope the so-called high-temperature insulations; the new committee will undertake work on insulations for use at somewhat lower temperatures, as for example, in the piping field and similar type industrial insulations.

The personnel of the committee has been developed on this basis. For the time being it is not proposed to include the housing insulations, although a number of tests applicable to the industrial insulations will no doubt also be of interest in connection with other types of insulation.

At the organization meeting on March 10 the committee discussed the possibility of developing tests for the following properties:

Handleability	Shrinkage on drying (plastic materials)
Hardness	Slump (of plastic materials)
Abrasive resistance	Coverage (of plastic materials)
Modulus of rupture	Adhesiveness (of plastic materials)
Compressive strength	Surface finish (of plastic materials)
Loss of weight	Vibratory tests
Volume shrinkage	

Mention was also made of the various thermal properties of interest in addition to thermal conductivity, namely, properties such as specific heat, coefficient of expansion, etc. The committee is working in close cooperation with the American Society of Heating and Ventilating Engineers, particularly with respect to the determination of thermal conductivity. The latter organization has been active in this field for a number of years.

A subcommittee organization will be developed to handle the various tests.

Temporary officers were elected at the meeting, including J. H. Walker, *Chairman*, and E. T. Cope, *Secretary*.

The present personnel of the committee is given in the following list:

COMMITTEE C-16 ON THERMAL INSULATING MATERIALS

Allcut, E. A., University of Toronto
American Society of Heating and Ventilating Engineers, W. A. Danielson and F. C. Houghten
American Society of Mechanical Engineers, R. H. Heilman
Bagsar, A. B., Sun Oil Co.
Carey Manufacturing Co., The Philip, H. W. Greider
Dickinson, H. C., National Bureau of Standards
Edison Electric Institute, E. T. Cope (temporary secretary)
General Electric Co., R. T. Girard
Johns-Manville Corp., C. B. Bradley
Keasbey & Mattison Co., William Morris
Massachusetts Institute of Technology, G. B. Wilkes
Owens-Illinois Glass Co., A. L. Simison
Peebles, J. C., Armour Institute of Technology
Pittsburgh Testing Laboratory, M. L. Carr
Plant Rubber and Asbestos Works, J. E. Kennedy
Queer, E. R., Pennsylvania State College
Sargent & Lundy, Inc., Andrew LeBailly
Standard Oil Development Co., B. A. Hollenbeck
Union Asbestos and Rubber Co., R. E. Cryor
U. S. Navy, Officer-in-Charge of the Specification Section, Design Division, Bureau of Engineering, and Director, Engineering Experiment Station, Annapolis
Walker, J. H. (temporary chairman), Detroit Edison Co.
Westinghouse Electric and Manufacturing Co., N. L. Mochel

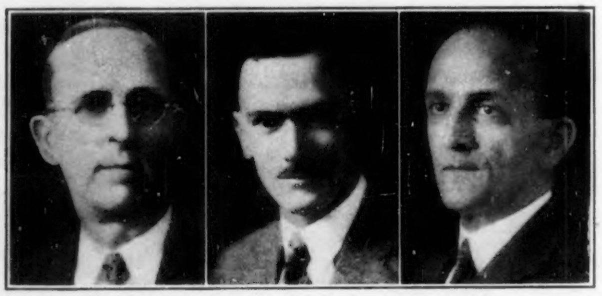
It is expected that this personnel will be augmented as the work of the committee gets under way since there is very great interest in this subject.

XVIII. Long-Time Society Committee Members

Eighteenth in the Series of Notes on Long-Time Members

There are presented below as a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, outlines of the work of three additional members. In general the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

P. L. WORMELEY, Chief, Testing and Specifications Section, National Bureau of Standards, Washington, D. C., received his technical education at the University of Virginia in mechanical engineering and electrical engineering, graduating in 1901. For a time he was engineer for the New Amsterdam Gas Co., Long Island City, N. Y., and then was Professor of Mechanical Engineering, College of Charleston, S. C. From 1904 to 1910 he was Engineer of Tests, U. S. Department of Agriculture, Washington, D. C., where he was in charge of the laboratory devoted to the investigation and testing of miscellaneous engineering and structural materials, particularly cement, concrete, and road



A. M. Muckenfuss S. H. Graf P. L. Wormeley

building materials. Since this time he has been at the National Bureau of Standards engaged in the investigation and testing of organic and fibrous materials, technical contributions on power losses in automobile tires, effect of reclaimed rubber on the wearing qualities of tire treads, and the testing of rubber goods.

Mr. Wormeley is one of the very early members of the Society, having become affiliated with it in 1904. For the most part, his A.S.T.M. activities have been devoted to the field of rubber. He has been a member of Committee D-11 on Rubber Products since its organization in 1912, serving on several subcommittees. At present he is a member of eight of them and in addition is a member of the Advisory Committee. He represents this committee on the Section on Thickness Measurement of Committee E-1 on Methods of Testing. Another committee activity is the Sectional Committee on Specifications for Rubber-Lined Fire Hose of which he has been chairman for a number of years.

S. H. GRAF, Professor of Mechanical Engineering, Oregon State Agricultural College, Corvallis, Ore., was educated in the Portland Public Schools and Oregon State College, receiving his degree of E.E. in 1908, M.E. in 1909 and M.S. in electrical engineering in 1909. Beginning with the rank of Assistant in Mechanical Engineering in 1908, he has been on the faculty at Oregon State College for thirty years. He was head of the Department of Experimental Engineering 1912 to 1920 and has been Professor and Department Head since 1914. He has been Director of Engineering Research since 1927 and Professor of Mechanical Engineering from 1934. His outside engineering practice has covered industrial and public utility plants and laboratories. He has been consulting engineer on a number of projects.

Professor Graf has been a member of A.S.T.M. since 1911. He has been especially interested in the work of Committee C-9 on Concrete and Concrete Aggregates, having served since 1915. He is on several subcommittees of this group and is also a member of numerous subcommittees of Committee D-3 on Gaseous Fuels.

In October, 1937, he was elected to the presidency of the National Council of State Boards of Engineering Examiners. He has represented the Oregon Board on several occasions. He is chairman of the Oregon Chapter, American Society for Metals, and is a member of a number of other professional and engineering organizations, and has been an officer of several engineering groups in Oregon.

A. M. MUCKENFUSS, Research Chemist, Melrose, Fla., was graduated from Wofford College in South Carolina, and Johns Hopkins University. Later he took advanced courses in organic chemistry and chemical engineering at a number of universities including Virginia, Chicago, Columbia University and Karlsruhe Technical College. He was head of the chemistry departments at Millsaps College, and at the Universities of Arkansas and Mississippi and Emory University. At three of these institutions he supervised the erection of new laboratory buildings.

His industrial activities include service as Research Chemist at Lowe Brothers Co., Patton Paint Co. (Pittsburgh Plate Glass Co.) and Roessler and Hasslacher Chemical Co. During twelve years' service for the latter company, he was in charge of research on industrial products originating with metallic sodium, a number of products being developed during that time. Later he was Acting Professor of Chemical Engineering at the University of Florida.

A member of the Society since 1909, he has been especially active in the work of Committee D-1 on Paint, Varnish, Lacquer, and Related Products of which he has been a member since 1914. One of his important services was as chairman of the Subcommittee on Anti-Fouling Paints. This committee conducted a number of submersion tests which resulted in the adoption of cuprous oxide as a standard for a toxic in shipbottom paints. He is also a member of Subcommittee VII on Accelerated Tests for Protective Coatings.

In 1914 he presented a very extensive "Report on a Permeability Test for Paints and Varnishes" covering, with resulting discussion, some 94 pages. This paper, one of the most extensive appearing in the *Proceedings,* created considerable interest and discussion. In view of the great interest at the present time in accelerated laboratory tests, it is interesting to note that H. A. Nelson in the introduction to the recently published A.S.T.M. symposium on the subject refers to Mr. Muckenfuss' work culminating in the *Proceedings* paper "as the first scientific attempt to study the application of an accelerated testing scheme to paint products intended for exterior service."

Committee on Radiographic Testing Organized

Meetings Held in New York City and Rochester

In order to carry out more effectively important work in the field of radiographic testing, there has been organized a new A.S.T.M. standing committee, designated Committee E-7 on Radiographic Testing. There has been increasing emphasis of the need for research and standardization work on important problems in this field and since the Symposium on Radiography and X-ray Diffraction Methods was held in Atlantic City in 1936, it has been apparent that a new A.S.T.M. committee in this field would be desirable as an extension of the work heretofore carried on by Committee E-4 on Metallography. H. H. Lester, Watertown Arsenal, was asked to take charge of developing preliminary plans for the committee.

The committee was formally organized on February 14 at a meeting held in New York City, of which a large number of those invited to serve on the committee were present. There was also a meeting held during A.S.T.M. Committee Week in Rochester, at which there was further discussion of a number of points involved in the projected committee work.

Permanent officers of Committee E-7 have been elected as follows: H. H. Lester, Watertown Arsenal, *Chairman;* and Earnshaw Cook, American Brake Shoe and Foundry Co., *Secretary.*

The list of subcommittees which are in course of formation indicates the general scope of the work—a formal statement of scope is in course of preparation. At both the New York and the Rochester meetings it was emphasized that the committee should work with similar groups in other societies and that the aim should be to cooperate, to correlate, but not to duplicate. In order to insure better cooperation, other radiographic committees are represented in the membership of E-7.

The six subcommittees which are being developed, together with the chairmen who will direct their work are indicated in the following list:

Subcommittee I on Radiography of Cast Metal—C. W. Briggs, American Foundrymen's Assn.
Subcommittee II on Technical Research—H. E. Seemann, Eastman Kodak Co.
Subcommittee III on Radiography of Welds and Weldments—H. H. Lester (temporary chairman), Watertown Arsenal.
Subcommittee IV on Correlated Abstracts—W. P. Davey, Pennsylvania State College.
Subcommittee V on Safety—E. W. Page, General Electric X-ray Corp.
Subcommittee VII on Programs—Lars Thomassen, University of Michigan.

In addition to these subgroups, in view of the importance of starting work immediately on radiographic inspection of certain special products such as valves and fittings where castings, forgings and similar parts are welded, it was decided to organize a section of Subcommittee III to work in cooperation with Subcommittee I.

It has been decided to hold another meeting of the committee in June during the A.S.T.M. Annual Meeting in Atlantic City. At this meeting reports are to be presented by the Subcommittees on Correlated Abstracts and on Program. One of the main features of the meeting is to be a technical session at which there will be several papers presented on radiographic activities of direct interest to the work of the committee.

COMMITTEE PERSONNEL

A number of outstanding authorities in the radiographic field were invited to become members of this new committee. The present personnel is as follows:

PERSONNEL OF COMMITTEE E-7

C. A. Adams, Edward G. Budd Manufacturing Co.
American Brake Shoe and Foundry Co., Earnshaw Cook
American Chain and Cable Co., Inc., L. C. Wilson
American Foundrymen's Assn., C. W. Briggs
American Steel Foundries, W. C. Hamilton
The Babcock & Wilcox Co., J. C. Hodge
Bell Telephone Laboratories, Inc., L. E. Abbott
The Bonney-Floyd Co., R. H. Frank
Combustion Engineering Co., Inc., Hedges-Walsh-Weidner Div., E. C. Chapman
J. J. Curran, Walworth Co.
P. D. Ffield, Bethlehem Shipbuilding Corp., Ltd.
Ford Motor Co., D. M. McCutcheon
General Alloys Co., G. C. McCormick
General Electric Co., W. G. Conant
Gulf Research and Development Co., B. B. Wescott
Victor Hicks, Westinghouse X-ray Co.
H. R. Isenburger, St. John X-ray Service, Inc.
G. F. Jenks, U. S. Army, Ordnance Dept.
The M. W. Kellogg Co., A. Kidd
Lebanon Steel Foundry, Fred Grotts
H. H. Lester, Watertown Arsenal
J. P. Magos, Crane Co.
V. T. Malcolm, Chapman Valve Manufacturing Co.
Maryland Casualty Co., A. G. L. Barkow
P. E. McKinney, Bethlehem Steel Co., Inc.
N. L. Mochel, Westinghouse Electric and Manufacturing Co.
J. T. Norton, Massachusetts Institute of Technology
The Ohio Steel Foundry Co., E. H. Mebs
E. W. Page, General Electric X-ray Corp.
Lucius Pitkin, Inc., Alexander Gobus
H. E. Seemann, Eastman Kodak Co.
Shell Petroleum Corp., G. C. Dick
A. O. Smith Corp., C. W. Wheatley
Standard Oil Development Co., F. C. Fyke
Steel Founders' Society of America, J. H. Hall
Lars Thomassen, University of Michigan
Union Carbide and Carbon Research Laboratories, Inc., C. O. Burgess
U. S. Navy, Bureau of Engineering, Specifications Section, Design Division
K. R. Van Horn, Aluminum Company of America

Consulting Members

W. P. Davey, Pennsylvania State College
G. E. Doan, Lehigh University
R. A. Gezelius, Taylor-Wharton Iron and Steel Co.
N. A. Kahn, U. S. Navy Yard, Brooklyn

The personnel of the several subcommittees which are being organized will be made up of members of the main committee.

Discussion of Plastics Symposium

Members of the Society and others who wish to submit written discussion of the six papers comprising the Symposium on Plastics, held as the technical feature of the Rochester Regional Meeting of the Society, are requested to submit copies of their discussion in duplicate as soon as possible. The Committee on Papers and Publications has set April 27 as the closing date.

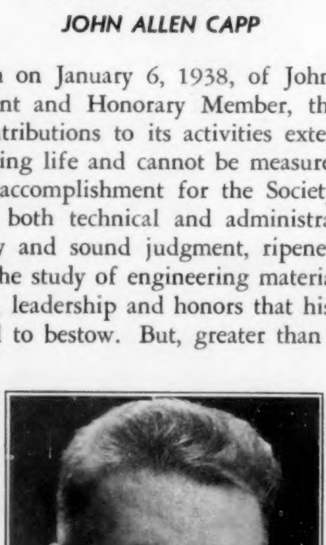
JOHN ALLEN CAPP
1870-1938

A short news note in the January BULLETIN announced the sudden death of John A. Capp, Materials Engineer, General Electric Co. He died as a result of complications from an operation on January 3 for appendicitis.

The Executive Committee of the Society has adopted a minute on the death of Mr. Capp, which gives information on his life and accomplishments, pointing especially to his numerous and long-time services for the Society.

Minute on the Death of
JOHN ALLEN CAPP

IN THE death on January 6, 1938, of John Allen Capp, Past-President and Honorary Member, the Society lost one whose contributions to its activities extended over his entire engineering life and cannot be measured by ordinary standards. In accomplishment for the Society he excelled; he brought to both technical and administrative work an inherent ability and sound judgment, ripened by years of experience in the study of engineering materials, that led to responsibilities, leadership and honors that his fellow workers were proud to bestow. But, greater than these tangible



accomplishments were the intangible spirit and ideals that he had; spirit to throw himself wholeheartedly into any task assigned to him; ideals that were of the highest, guiding him in everything he undertook and especially in the difficult task of reconciling the oft-times conflicting viewpoints of producers and consumers, with the ever-present human side to such work.

He himself had referred to the Society's committee work as a course in human engineering, in which there are no formal curricula, no professors, in fact, no graduation, deeming this course to be of great value to all who would participate in it, especially to the younger men in whom he was always interested. His own life in the Society is an inspiring illustration of the value of this course in human engineering, to which in his later years he contributed so much.

Mr. Capp's life was spent in the electrical manufacturing industry. He was born in 1870 in Philadelphia. Graduating in Mechanical Engineering from the University of Pennsylvania in 1892, he became associated with the Thomson-Houston Company at Lynn, Mass. Shortly thereafter he went to the main plant of the General Electric Company at Schenectady, N. Y., where he became chief of the testing laboratory. In 1927, when the Works Laboratory was established, he was its head as Engineer of Materials, a post that he held until his death. While much of the work in his forty-five years of engineering activity was done in the metals field, he made many contributions to the non-metals field, notably in petroleum products, fuels, and electrical insulating materials.

His affiliation with this Society dates from 1898, the year of organization of the American Section of the International Association for Testing Materials. He served as a member of some eighteen committees, to which he made many important technical contributions. Perhaps his outstanding work was as chairman since its organization in 1909 of Committee B-1 on Copper and Copper Alloy Wires for Electrical Conductors,—then Committee W on Copper Wire,—where his expert knowledge of tests and properties of non-ferrous wire products and his organizing and executive abilities contributed to the development of specifications and methods that have for years been the standards of that industry. He was long active in Committee A-1 on Steel, heading up various subcommittees and serving as vice-chairman 1913 to 1917 and chairman 1918. In 1920, the important task of reorganizing Committee E-1 on Methods of Testing was placed in his able hands and he continued as chairman until 1927.

In 1917 he was elected to the Executive Committee of the Society and after serving for two years, was elected President in 1919. Here he served our Society ably. At that time, he was appointed (together with Edgar Marburg and A. A. Stevenson) to develop with representatives of other societies the plans for organizing the American Engineering Standards Committee, now the American Standards Association. Mr. Capp served continuously since 1918 as an A.S.T.M. representative in that organization, and his untiring efforts in that field of standardization will stand as one of his most enduring monuments.

At the annual meeting of the Society in June, 1937, he received the award of Honorary Member of the Society, an honor which he richly merited.

He was also a member of the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Foundrymen's Association, American Society for Metals, the Institute of Metals (British) and the British Iron and Steel Institute.

His death removes from our midst one who had endeared himself to all who knew him for his sterling qualities of sincerity, integrity, fairness and courage, as well as his friendliness and his helpfulness to the younger men of his profession. The officers and members of the Society mourn his passing and extend their heartfelt sympathies to his family. They will cherish the years of association with him, and his life will ever be an inspiration to them as they carry on the task that he himself so ably performed.

Golden Anniversary of Robert W. Hunt Co.

DURING 1938 the Robert W. Hunt Co., engineers, will celebrate its Golden Anniversary, having completed fifty years of service to the construction, railroad, and manufacturing industry. The company was started in 1888 by Captain Robert W. Hunt and associates. Its primary purpose was inspection of rail steel, but it was later expanded to other railroad materials and equipment. About the same time a similar service was inaugurated for the construction industry covering various engineering materials, and later supervision of the erection of steel and concrete structures.

Captain Hunt, Past-President A.S.T.M. (1912-1913), was a pioneer in the manufacture of iron and steel and of historical interest are the experimental Bessemer converters built at Wyandotte, Mich., in 1865, and the first commercial rolling of steel rails at the Cambria Works in 1867 under his superintendence. Among the many honors received by him in recognition of his services to industry were the John Fritz Medal and the Washington Award.

During the World War, the organization placed its facilities at the disposal of the U. S. Government for the inspection and testing of war materials and machinery, and in recognition of these services, a special award was received. Included in its activities is inspection work for over 50 per cent of the U. S. railroads, including complete inspection of rails for railroads representing 65 per cent of track mileage.

Fire Codes for Flammable Liquids and Gases

THERE has recently been issued by the National Fire Protection Association a compilation on "National Fire Codes for Flammable Liquids and Gases." This volume includes thirty-six standards and regulations giving fire protection authorities complete information on the safe handling of both flammable liquids and gases. The several codes are in the form of suggested ordinances, regulations, or recommended good practice requirements, depending upon the character of the principal use of each. The history of each standard is given in the introductory note preceding it.

In performance of its function of developing and making available information on the safeguarding of life and property against loss by fire, the N.F.P.A. since its organization in 1896 has prepared some 150 standards on various phases of fire prevention and protection. These standards are purely advisory, but are widely used as a basis of law, or as a guide by administrative authorities in the exercise of their discretionary powers, as well as for insurance purposes.

Copies of this 360-page publication, in heavy paper cover, can be obtained from the N.F.P.A. Office, 60 Batterymarch St., Boston, Mass., at $1.50 each.

The Effect of Manufacturing Variables on the Creep Resistance of Various Steels

APPEARING in the 1937 Report of the Joint Research Committee on Effect of Temperature on the Properties of Metals[1] as Appendix IV, was a note by H. W. Gillett on "Discrepancies in the Load-Carrying Abilities of Carbon Steels at 850 F." This very timely article reviewed the literature on creep tests on carbon steels, and pointed out the huge differences in creep behavior in supposedly similar steels. The methods of melting, the grain size, the heat treatment used, all appeared to have marked effects.

Recognizing this matter as one of the most important considerations confronting those interested in the use of metals at high temperatures, the Joint Research Committee last summer authorized a project to make "a preliminary study of effects of manufacturing variables on the creep resistance of steels." A progress report will be made at the A.S.T.M. annual meeting in June. The report will show the results of creep tests at 850 F. on twelve plain carbon steels with known aluminum additions, and one carbon-vanadium steel. Some of the steels have been intentionally coarsened by suitable treatments, in order to compare the creep behavior of coarse and fine-grained steels.

It is believed that the report will be another milestone in our better understanding of the problem of creep.

Messrs. Morgan and Farmer on A. S. A. Council

MALCOLM F. FARMER, Vice-President and Chief Engineer, Electrical Testing Laboratories, New York City, has been reappointed A.S.T.M. representative on the Standards Council of the American Standards Association for a term of three years. Mr. Farmer, who is chairman of the Council, has served as one of the A.S.T.M. representatives for a number of years.

To succeed the late J. A. Capp, who served as an A.S.T.M. representative on the Council since it was organized and who took a leading part in the development of the American Standards Association from the beginning, President White has appointed H. H. Morgan, Manager, Rail and Fastenings Dept. Robert W. Hunt Co., Chicago. Mr. Morgan has been chairman for a number of years of Sectional Committee B 36 on Standardization of Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing, this committee functioning under A.S.A. procedure, and he is now completing his second term as chairman of Committee A-1 on Steel. Mr. Morgan's term on the Council will expire December 31, 1939.

Committee on Magnetic Properties Meets

AT A well-attended meeting of Committee A-6 on Magnetic Properties held at A.S.T.M. Headquarters on Friday, February 18, certain minor revisions in the definitions of terms relating to magnetic testing were approved and are to be submitted to letter ballot of the committee. Consideration was given to a number of additional terms which may require definitions.

The results of recent intercomparisons carried on by the subcommittee on direct current test methods in connection with testing at high magnetizing forces were presented and discussed and further work was agreed upon.

One of the important actions taken at the meeting was to approve for submission to letter ballot of the committee proposed test requirements covering interlamination resistance, these having been developed by the subcommittee on alternating current test methods. The question of the use of smaller specimens for core loss testing was discussed and referred to the subcommittee for further study.

[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 37, Part I, pp. 164-192 (1937).

Committee Week

Activities Summarized

(Continued from page 10)

After several years of intensive work, proposed methods for temperature resistance constants of sheet materials for shunts and precision resistors have been prepared and are to be submitted for publication as tentative. A new method for the bend testing of wire has also been prepared for submission as a tentative standard. High temperature bend test equipment for testing bars for structural elements of electric furnaces has been developed and given a preliminary trial. Tests soon will be under way at 1800 F. with different loads, with a view to developing a standard method of test.

An investigation is being made to develop a test for warpage of bars for electric furnace work.

Considerable work has been done in studying the effect of different furnace atmospheres upon the life of electric furnace resistors, and valuable information is being obtained with a view to the development of a standard method of test for determining the life of resistors under such conditions.

The new subcommittee on metallic materials for radio tubes and incandescent lamps has developed a method of test for cathode sleeves and filament materials which will be sent out for comment.

Committee B-5 on Copper and Copper Alloys, Cast and Wrought

Committee B-5 approved for submission as a proposed new standard, specifications covering rolled non-ferrous bearing and expansion plates, these covering plates used in bridges and other structures for fixed or expansion bearings where motion is slow and intermittent and pressure does not exceed 3000 lb. per sq. in. The plates are to be a homogeneous alloy of copper and tin or of copper and silicon and may contain certain other elements. Physical properties provide a minimum tensile strength of 65,000 lb. per sq. in., a minimum Brinell hardness of 130 for plates $\frac{1}{4}$ in. and thicker, and a compression yield strength (0.1 per cent set) of 25,000 lb. per sq. in. minimum.

New specifications for sheet and strip brasses are also to be recommended to replace the existing standard specifications for sheet high brass (B 36). Subject to letter ballot of the committee revisions will be submitted in the tentative specifications for bronze castings for turntables and movable bridges (B 22) and tentative revisions are being proposed in the chemical composition requirements of the specifications for aluminum-bronze castings (B 59 – 36).

At the same time the committee took action to recommend the adoption as standard of the tentative specifications for bronze castings in the rough for locomotive wearing parts (B 66) and for car and tender journal bearings lined (B 67) and to withdraw the existing standards for sand castings of the alloy, copper, 80 per cent, tin, 10 per cent, lead, 10 per cent (B 74) and yellow brass sand castings for general purposes (B 65).

In the specifications covering manganese bronze ingots (B 7) and sand castings (B 54), two alloys of higher tensile strength and lower elongation in which manganese is used as the deoxidizer are under consideration for incorporation. The committee is working on standardized requirements for the nickel-bearing copper alloys which include compositions up to 31 per cent nickel. Another study under way in the committee is the possibility of a general regrouping and reclassification of the various standards covering casting alloys.

Details of the reorganization of the committee were reviewed at the meeting. It is planned to set up twelve new subcommittees, as follows:

1. Copper-Zinc Sheet and Strip
2. Copper-Tin Sheet and Strip
3. Copper-Nickel-Zinc Sheet and Strip
4. Miscellaneous Sheet and Strip
5. Miscellaneous Copper-Base Wire and Rod Alloys
6. Condenser Tubes
7. Copper Tubes
8. Copper Alloy Tubes for General Use
9. Copper-Base Alloy Forgings
10. Copper-Base Alloys for Sand Castings (50 per cent or over copper)
11. Methods of Test
12. Committee on Publication of General Information

Committee B-6 on Die-Cast Metals and Alloys

As a result of action taken at its meeting, Committee B-6 proposes to amplify the tentative specifications for zinc-base alloy die castings (B 86) by the addition of a new alloy No. XXV. This new alloy differs in composition from the present alloy No. XXI in that its copper content is 1 per cent. The new alloy has physical properties in between those of the present alloys Nos. XXI and XXIII.

The committee received a satisfactory progress report concerning the studies which are being undertaken on five tin-base and lead-base die casting alloys to determine the tensile strength, creep, impact resistance and hardness. The committee has obtained a set of test specimens to carry out this investigation.

The exposure and corrosion test program formulated last year is now getting under way and it is expected that the three zinc-base alloys and the four magnesium-base alloys included in this study will be placed on the exposure racks during the summer. The zinc-base alloys have been prepared by the Apex Smelting Co., National Cash Register Co., the New Jersey Zinc Co., Bunker Hill Zinc Products, Stewart Die-Casting Corp., and the Superior Die-Casting Co. The magnesium-base alloy specimens have been produced by the Hoover Co., Dow Chemical Co., and the American Magnesium Corp.

It was agreed that alloy No. 12 of the tentative specifications for magnesium-base alloy ingot for remelting (B 93) should be included in the exposure tests under the designation of alloy No. 312 and an alloy of the composition of No. 7 under the designation 307. Two additional alloys designated 313 and 314 will also be included, the former having a nominal composition of 9 per cent aluminum and 0.6 per cent zinc, the latter differing from 307 by the addition of 2.5 per cent zinc. The New Jersey Zinc Co. is making the chemical analysis of the zinc-base specimens, and the Dow Chemical Co., the magnesium specimens. All of the zinc alloys will be die cast in accordance with the procedure outlined in the report last year by G. L. Werley on "A Study of Die Design Changes for the Improvement of the Soundness and Uniformity of Test Bars," which was published in an appendix to the 1937 Report of Committee B-6. The

magnesium-base alloy specimens will be prepared under standard conditions of casting in order that variables will be reduced to a minimum.

The subcommittee on magnesium-base die-casting alloys reported that studies are now being made on two new magnesium alloys which appear to have desirable properties and the further development of which would appear to offer favorable possibilities for use in the manufacture of die castings. The alloys in question have the following approximate composition: 9 per cent aluminum, 1 per cent zinc, 0.1 per cent manganese; 6 per cent aluminum, 2 per cent zinc, and 0.15 per cent manganese, the remainder being magnesium, with the usual limitations on impurities.

Committee B-7 on Light Metals and Alloys, Cast and Wrought

Detailed consideration of numerous specifications took place at the meeting of Committee B-7. Some revisions are to be proposed involving composition of the aluminum-base alloys in ingot form for permanent mold castings (B 112). There are also in prospect some modifications in the aluminum-base alloy permanent mold castings (B 108). It is expected that these will be referred to the Society for approval at the annual meeting in Atlantic City in June.

In order to incorporate minimum tensile strength requirements covering annealed plate which have been indicated as necessary for the purpose of design in boiler and pressure vessel construction, changes are to be recommended in the tentative specifications for aluminum sheet and plate (B 25) and for aluminum-manganese alloy sheet and plate (B 79).

In its work on magnesium-base alloys, changes have been developed in five of the specifications. In those covering magnesium ingot for remelting (B 93), a forging and a casting alloy are being deleted and three new alloys are to be added: one for casting, one used for press forging and for bars, rods and shapes, and a third for hammered forgings. The specifications for magnesium-base alloy sheet (B 90) are to be amplified by the addition of alloy No. 7 which has desirable physical properties and approaches the formability of sheet alloy No. 6. The forging standard (B 91) will be changed by the deletion of alloys Nos. 7 and 10, little used today, and the addition of No. 15 which has good press forging characteristics and offers better corrosion resistance than some other alloys. Alloy No. 16 will also be added. This is the best magnesium-hammer forging alloy with physical properties about the same as alloy No. 6, but its salt water corrosion resistance is distinctly better.

Alloy No. 15 will be incorporated in the tentative specifications for magnesium-base alloy bars, rods and shapes (B 107). This possesses an excellent combination of physical properties and salt water corrosion resistance and it can be heat treated and aged, in which condition its yield strength is equal to that of the other alloys.

The active work which has been under way on anodic oxidation of aluminum and aluminum alloys has resulted in proposed new methods of testing anodized aluminum for dielectric strength. It is expected these methods will be submitted to the Society for publication as tentative. The subcommittee in this field is also studying abrasion tests of anodized coatings.

Research Committee on Fatigue of Metals

The Research Committee on Fatigue of Metals at its meeting started a project studying the comparison of results of fatigue tests made on different types of testing machines in common use.

Are results obtained with one type of machine the same as those obtained on another? Or must a "machine factor" be considered? These are some of the questions which need to be answered.

After the discussion of this project, items of interest in the fatigue failures of metals in service were considered. How can the beginning of fatigue fracture (by a spreading crack) be detected? X-ray spectrographs, dying out of vibrations in metals, and change of strength properties of metals before complete fracture were mentioned, and none of these seems developed to a usable state yet.

Various experiences with fatigue tests were exchanged and an interesting report of a rather marked effect of a magnetic field on fatigue strength of notched bars was reported. Reports of tests of full size riveted and welded joints were reported, and interesting tests on airplane parts.

Committee C-14 on Glass and Glass Products

The meeting of Committee C-14 was an extended one covering both the morning and afternoon of March 8. A number of organization matters were discussed.

Much of the meeting was devoted to reports of the six subcommittees concerning nomenclature and definitions, chemical analysis, chemical properties, physical and mechanical properties, thermal properties and glass construction block and tile.

One of the problems which was reviewed in detail concerned the heat transfer properties of glass. Research problems concerning chemical durability of glass were discussed and a program outlined. A third point, which was of particular interest also, concerned a review of desirable research work on glass building block. Various members of the committee will take part in cooperative research plans which were outlined.

Among present phases of the work of Committee C-14 which are receiving study and investigation are proposed test methods covering the chemical analysis of glass sands, the determination of the tensile strength of glass, and method of determining bending strength of glass.

Committee D-1 on Paint, Varnish, Lacquer, and Related Products

As a result of numerous meetings of subcommittees and sections and a main meeting, Committee D-1 on Paint, Varnish, Lacquer, and Related Products reported the development of seven new proposed standards which are to be recommended to the Society for publication as tentative. A number of changes in existing standards were proposed and because of the possibility of combining requirements given in a number of existing tests and specifications, several of the latter are to be withdrawn.

At the meeting of the main committee on March 8, there were two papers presented as follows: "Some Requirements for Cold Water Paste Paints" by A. J. Eickhoff, Chemist,

National Bureau of Standards, and "The Present Status of Accelerated Testing and Plans for Its Further Development" by H. A. Nelson, Assistant to General Manager, Technical Dept., The New Jersey Zinc Co.

The committee approved the appointment of a new subgroup to develop a project that will cover the problems of adhesion and adhesion testing, together with the drafting of appropriate recommendations regarding methods of procedure.

A new subcommittee was appointed to be known as Subcommittee XXIX on the Painting of Structural Iron and Steel. A. J. Eickhoff, Chemist, National Bureau of Standards, will serve as chairman of this new group.

The committee accepted a report from their representative on the Inter-Society Color Council and indicated, by vote, their desire to continue to participate in the activities of the council through the medium of their delegates. In connection with this work, Dr. A. W. Kenney, E. I. du Pont de Nemours and Co., Inc., a member of Committee D-1, is now engaged in a survey of color terms, tests, and problems common to the paint, varnish and lacquer industry and also of color specifications in industry.

One of the projects on which the committee is working involves the development of definitions of gloss and methods of tests for gloss of paints, varnishes and lacquer films. The method which is being developed contemplates the use of a goniophotometer.

A detailed list of materials covered in the new standards which are to be recommended by Committee D-1 to the Society follows. It will be noted that two of these are consolidations of several existing specifications which the committee proposes to withdraw.

Interior Flat Paint (Oil or Varnish Base) Ready-Mixed and Semi-Paste, Light Tints and White
Para Red Toner
Zinc Chromate Yellow
Titanium Dioxide Pigments (combining previously issued specifications covering: Titanium Barium Pigment (D 382), Titanium Calcium Pigment (D 383), Titanium Dioxide (D 384), and Zinc Sulfide Magnesium Pigments (D 443)
Zinc Sulfide Pigments (combining previously issued specifications covering: Lithopone (D 208), Zinc-Sulfide—Barium Pigment (D 385), Zinc Sulfide (D 386), and Zinc Sulfide Magnesium Pigment (D 443)
Aluminum Pigment Paste for Paint
Methods of Test for Sampling and Testing Aluminum Powder and Aluminum Paste

The various subcommittees in charge have been developing needed changes in certain of the previously issued specifications and their recommendations were approved at the D-1 meeting to be included for action in the 1938 annual report of the committee, the specifications involved covering the following materials:

Normal Butyl Acetate (88 to 92 per cent Grade) (D 303)
Butyl Propionate (90 to 93 per cent Grade) (D 320)
Ethyl Lactate (Synthetic) (D 321)
Red Lead (D 83)
Commercial Para Red (D 264)
Aluminum Powder for Paints (Aluminum Bronze Powder) (D 266)

Three proposed standards which were published in 1935 as tentative and another issued in 1937 are to be referred to letter ballot for adoption as standard this year. These specifications and tests cover the following:

Basic Sulfate White Lead (D 82)
Blue Lead; Basic Sulfate (D 405)
Wood to be Used as Panels in Weather Tests of Paints and Varnishes (D 358)
Oleo-Resinous Varnishes (Skinning Test, Alkali Resistance, Acid Number) (D 154)

Committee D-17 on Naval Stores

Committee D-17 on Naval Stores reported important progress in its active program. Proposed methods of sampling and grading rosin are to be recommended to the Society for publication as tentative.

Proposed methods of test for the determination of the chemical constants of rosin (ash, petroleum ether insoluble, volatile matter, and unsaponifiable matter) are being studied and it is expected that as a result of the testing of referee samples by cooperative efforts of members, test procedures will be developed.

The committee is planning eventually to combine all the methods covering testing of rosin in a general consolidated test under the general heading of "Methods of Analysis of Rosin" that is, methods of tests for analysis (determining chemical and physical constants of rosin). This program anticipates that the tentative methods of test for acid number (D 465) and for saponification number (D 464) eventually will be published with the new methods in the general tests for rosin.

Committee D-3 on Gaseous Fuels

Committee D-3 and its seven subcommittees met during Committee Week. Progress reports were submitted by each of the seven subcommittees. While no standards on gaseous fuels were submitted for approval of the main committee, a fair degree of progress has been made in conducting research on methods of analysis of gases and in determining the calorific value and specific gravity of gases. Arrangements have been made with the National Bureau of Standards for conducting comparisons of different types of apparatus for determining specific gravity. This Bureau also is continuing work on the study of equipment and methods for metering gas for analytical and testing purposes and will send standard samples of different types of gases to committee member laboratories for comparison of methods of gas analysis.

Preliminary drafts of methods for determining hydrogen-sulfide sulfur and total sulfur in fuel gases have been drafted and submitted for comment to members of the subcommittee on determination of impurities of gaseous fuels.

Committee D-5 on Coal and Coke

There was approved for presentation to the Society for publication as a tentative standard, a scheme of sampling coals classed according to ash content. This method is intended to apply to average commercial sampling of coal and is designed to give results so that 95 per cent of the test results fall within 10 per cent of the true ash content of the coal samples. The method also gives instructions for sampling for purposes requiring special accuracy, such as classification of coals by grade or rank and for performance test work. Coals are divided into groups according to size and each group is subdivided according to ash content. For each size and range of ash content, the method specifies the minimum number of increments to be taken in collecting

gross samples; also the minimum weight of each increment is given together with the minimum weight of gross samples.

This method of coal sampling is the result of a number of years' intensive investigation by coal consumers and coal producers to develop a practical method of coal sampling, scientifically sound in principle, whereby coals can be sampled with the minimum cost and yet with satisfactory accuracy for commercial purposes.

The committee approved a revision of the procedure for determination of coal ash fusibility, covered in the Methods of Analysis of Coal and Coke (D 271), which will permit the use of either gas fired or electrically heated furnaces which meet specified requirements. This revision is necessary because of the development in recent years of a number of furnaces suitable for the determination of coal ash fusibility. Furnaces which have been tested by the committee and found satisfactory are listed.

The subcommittee on plasticity and swelling of coal reported gratifying progress on experimental work being conducted to standardize methods for determining the swelling or expanding characteristics of coals when carbonized for manufacture of coke.

Coal expansion during coking is very important in the selection of coals for coke manufacture, as strongly swelling coals cause damage to the coke oven walls. The subcommittee recently held a meeting at Johnstown, Pa., and inspected the equipment for testing coal expansion as used by the Bethlehem Steel Company when plans were made for testing different ranks of coking coals by different methods as used in various laboratories in this country and in Canada. These cooperative tests will be of much value in the standardization of a suitable method for testing expanding characteristics of various coals during carbonization.

Committee D-4 on Road and Paving Materials

One of the important actions approved at the meeting of Committee D-4 was the recommendation involving a new method of test for determining the particle size distribution of fine and coarse aggregates using sieves with square openings, to be published as tentative. Although the method is also applicable to the use of laboratory screens with round openings it is not intended for use in the sieve analysis of aggregates recovered from bituminous mixtures. This proposed standard was prepared by a joint conference committee representing Committee C-9 on Concrete and Concrete Aggregates and Committee D-4, under the chairmanship of Mr. E. F. Kelly, Chief, Division of Tests, U. S. Bureau of Public Roads. It is intended to replace four existing standard methods covering the mechanical analysis of aggregates issued under the A.S.T.M. designations: C 41, D 7, D 18 and D 19.

There were presented proposed new specifications for tar which include detailed purchase requirements for 14 grades of tars used in road construction. These comprehensive specifications are intended to replace four existing specifications.

The subcommittee on waterbound and traffic-bound roads presented two new specifications covering, respectively, crushed stone and crushed slag for waterbound base and surface course. These specifications were approved for reference to letter ballot of the committee.

The group concerned with bituminous macadam surfaces and bases submitted two new specifications for crushed stone and crushed slag, respectively, intended for bituminous macadam base and surface course, and two new specifications for crushed slag and for crushed stone, respectively, for bituminous concrete base and surface courses were reported for action.

Proposed specifications for asphalt plank were accepted by Committee D-4 for publication as information in the 1938 annual report. It is intended that the specifications will be submitted to the Society following the June annual meeting for publication as tentative.

As the result of cooperative studies carried on during the year, the committee has prepared several revisions of the tentative test for abrasion of coarse aggregate by use of the Los Angeles machine (C 131). The committee accepted for publication as tentative several proposed revisions in the Standard Method of Test for Ductility of Bituminous Materials (D 113 – 35) which will be published during the year. The tentative revisions of the Standard Method of Test for Softening Point of Tar Products (Cube-in-Water Method) (D 61 – 24) which have been published during the past year will be recommended for adoption as standard.

Committee D-8 on Bituminous Waterproofing and Roofing Materials

Committee D-8 has been extremely active during the past year and a number of recommendations were acted upon at the Rochester meeting which will be considered formally by letter ballot.

There were presented proposed specifications for asphalt mastic suitable for use in waterproofing which cover a material consisting of asphalt cement, mineral filler and mineral aggregate. The grade of asphalt mastic covered is suitable for waterproofing the floors of buildings and bridges, or reservoirs, waterways, subways, etc.

The work on membrane materials has been very active and it has resulted in revisions and modifications being presented in the following: specifications for asphalt-saturated roofing felt for use in waterproofing and in constructing built-up roofs (D 226) will be revised to include 30 lb. material in order to bring this standard up to date. Revisions in the standard for woven cotton fabrics saturated with bituminous substances for use in waterproofing (D 173), in order that they will be in agreement with present practice, involve the inclusion of a provision for spraying the saturant in the manufacture of the saturated fabrics and also changes in certain of the physical properties including moisture, pliability tests and weight of saturant.

As a result of the changes in the pliability requirements for saturated felts and fabrics, a revision in the pliability test procedure was recommended for inclusion in the standard methods of testing felted and woven fabrics (D 146).

On behalf of Subcommittee X on Standard Coefficient of Expansion for Bituminous Products, W. H. Fulweiler, Consulting Chemist, presented a report indicating that there appeared to be a lineal relation between the specific gravity and coefficient of expansion. He stated that the subcommittee will recommend for action at the June meeting the adoption of the following coefficients—following the prac-

tice of the work on petroleum products, there will be four classes of material:

Type of Material	*Coefficent of Expansion*
Creosote Oils	0.00040 per deg. F.
Primers	0.00035
Cements	0.00030
Pitches	0.00026

It was pointed out that these figures represent current practice by a number of states and the industry.

A report covering studies on the quantitative analysis of different types of fibers in roofing felt was presented and it is planned to include the results of this study in the annual report of the committee.

Committee D-18 on Soils for Engineering Purposes

The work of Committee D-18 is divided among eleven subcommittees all of which presented reports during Committee Week, indicating definite progress in their work.

The subcommittee on stabilization, divided into groups according to the interest in various methods for stabilizing soils, has been studying the applicability of the generally accepted methods of tests of soils to the particular methods of stabilization. The portland cement group reported that four of the tests being considered are applicable to the study of soils stabilized with portland cement. These tests are for moisture density, freezing and thawing, wetting and drying, and shrinkage and swell. It is expected these test methods will be given consideration by the general committee, and at least presented as information, at an early date.

The calcium chloride group reported that the method of test for determination of percentage of voids and density, were the only methods of tests of those submitted for consideration which were applicable to the study of stabilization of natural soils with calcium chloride.

A method of test for determining shear of soils in service in roads is being developed and the results obtained to date indicate the method may present valuable data in regard to calcium chloride and soil bound mixtures.

The subcommittee on compressibility and elasticity of soils presented a particularly satisfactory report on the correlation of the various methods of making tests on compressibility of soils, with the purpose of developing a standard method.

Careful study has been made of the present standard method of tests of soils for engineering purposes and some recommendations for revisions to bring these methods up to date have been submitted to the general committee.

Committee D-11 on Rubber Products

Extension of the work of Committee D-11 into important fields not now covered was considered at the committee's meeting and actions to start work in the near future were approved. One of the fields involves sponge rubber—a new committee being in course of organization under the chairmanship of Mr. Gould of the Miller Rubber Co. This subcommittee is desirous of obtaining information from interested parties who have undertaken testing and research work and would appreciate hearing from them.

There was an excellent organization meeting of the new subcommittee dealing with hard rubber, functioning under the chairmanship of W. H. Juve, Consulting Rubber Technologist. Three sections were appointed—the first to undertake the standardization of chemical tests of hard rubber, the second, methods of determining physical properties, and the third to standardize procedures for measuring electrical properties. A detailed list of important requirements for hard rubber has been drawn up, this to serve as a basis for further study by the subcommittee. The importance of work in this field is recognized because of the rather widespread use of hard rubber in such fields as electric storage batteries, telephone and telegraph work, radio panels, chemical research and rubber-lined pipe and tanks.

Another important development announced at the meeting was the development of a source of supply for standard reference samples having certified abrasion properties. The committee feels that the availability of abrasion standards is an important accomplishment which will be of considerable service to many interests in the industry. Experience and studies with the samples during the past six months have indicated they can be maintained within $\pm$ 5 per cent. This is considered an unusual result for a mechanical service test of this nature.

Because of constructive criticism of revisions proposed last year in the specifications for fire hose (D 296) the changes were modified and are to be recommended to the Society. It is planned to segregate the tests and chemical analyses and include suitable reference to appropriate standards.

In order to make the present methods of test for transmission belting (D 378) applicable to all types of belting, especially for grain elevator and conveyor use, revisions are being developed.

Changes in the existing test methods and specifications for wire are being worked on with especial attention to particular materials and also to tests for determining resistance to moisture and ozone action.

Work on valves and packings is to be renewed with a general review of existing specifications and the initiation of suitable test methods for this type of material. The committee felt it desirable to recommend a change in the title of the methods of physical testing of rubber products (general requirements) (D 15) to read "methods of sample preparation for physical testing of rubber products." In these methods the committee plans to incorporate requirements for gasoline used in separating rubber from the fabric.

Revisions in the specifications for fire hose (D 296) have necessitated certain modifications in the methods of chemical analysis (D 297). The subgroup in charge of this work is also active in studies of analytical procedures for determining copper, manganese and sulfur; considerable data are being obtained and studies of the amounts of these three elements present are being carried on spectroscopically.

The committee is continuing with a further study of life tests involving effect of pressure on the air pressure heat method (D 454). More scientific studies are being outlined. A new section is to be formed to study the effect of sunlight and artificial light aging on rubber. One of the first aims of this work is standardizing a method for conducting exposure tests.

In the field of hardness testing, work will be undertaken to determine the desired requirements for a portable hardness testing instrument in order that instrument manufacturers may have helpful information.

The committee will continue actively its program involving oil resistance, and plans to appoint sections to study the

physical properties of rubber after immersion in liquids. An effort is being made to obtain a supply of kerosene to use as a standard liquid.

A study of viscosity of liquid rubber products is being continued with a series of round-robin tests on two methods which appear to be most acceptable These two tests will be evaluated to determine which seems best. In cooperation with the Rubber Division of the American Chemical Society and the Research Association of British Rubber Manufacturers the committee will study methods for the examination of latex.

Committee D-12 on Soaps and Other Detergents

Further impetus was given to the active program of work which Committee D-12 has under way as a result of its two-day series of meetings held in New York City, March 7 and 8. New definitions for builder and detergents were approved and definitions for scouring were discussed in some detail.

Other important actions taken at the meeting involve the approval of proposed specification requirements covering white floating toilet soap, milled toilet soap, chip soap, powdered soap and laundry bar soap. The committee decided to concentrate its activities in the near future on specifications for liquid soaps, built soaps, soap powders, tri-sodium phosphate, metasilicate, etc.

During the year the committee has withdrawn previously existing definitions except those covering built soap and new ones have been prepared for soap, anhydrous soap, soap content, alkali detergents, builder and detergents, and also for the different physical states of soaps, such as solid soap, bulk soap, chip, powdered, bead, etc.

As a result of action at a previous meeting, the committee will include in its report to the Society at its annual meeting a recommendation that the following tentative specifications be adopted as standard: caustic soda (D 456), modified soda (sesquicarbonate type) (D 457), and soda ash (D 458).

The tentative methods of sampling and chemical analysis of soaps and soap products (D 460) are also to be adopted as standard on the recommendation of the committee. Methods for screen test, and the Lindo-Gladding method for potash are to be drafted for publication as tentative this year.

Committee D-20 on Plastics

Committee D-20 held a very enthusiastic and well-attended meeting in Rochester. The work of this committee includes the development of test methods applicable to the finished products (molding materials, sheets, tubes and rods, and molded or fabricated articles) in the field of plastics.

The committee has been giving detailed consideration to its program of work. All members have been canvassed for suggestions and recommendations concerning projects that should be initiated. As a result of this study the following five subcommittees have been organized: I on Strength Properties, II on Hardness Properties, III on Thermal Properties, IV on Optical Properties and V on Permanence Properties.

Subcommittee III on Thermal Properties reported very satisfactory progress on the initiation of a series of round-robin tests to study the flammability of thin sheet or film plastic material. Subcommittees IV on Optical Properties and V on Permanence Properties reported a considerable amount of work under way which it is expected will eventually result in the attaining of valuable information and data on these properties of plastics. After the results have been studied, the data will be presented to the Society in a report or through technical papers.

Committee on Laboratory Glassware

Technical Committee XII on Laboratory Glassware, of Committee E-1 on Methods of Testing, held an organization meeting in Rochester. This new committee, formerly a standing committee of the Society, with the designation Committee D-15, has in course of organization four subcommittees to handle specific phases of its work, these being as follows:

I. Thermometers
II. Hydrometers
III. Volumetric Glassware
IV. Laboratory Glassware

Since the work of this group is devoted largely to the preparation of specifications for glassware and thermometers for use by other A.S.T.M. standing committees, it is felt the work will be handled more efficiently under Committee E-1 because one of the principal functions of this administrative committee is to aid and advise other committees in matters relating to standard methods and testing instruments.

The personnel is to be expanded to include representatives from all other standing committees interested in thermometer and glassware specifications. Individual specifications are to be prepared covering each thermometer now specified in existing A.S.T.M. standards and tentative standards.

At the request of Committee D-1 (Subcommittee IX on Turpentine) specifications for special thermometers for temperature distillation are to be studied and prepared. Committee D-2 on Petroleum Products was requested to change the tolerance specification for the Babcock bottle for plant spray oils so as to permit use of the standard bottle. It is proposed that the 0.02 ml. now specified be changed to 0.025 ml. which is now the standard tolerance.

The proposed test for dropping point of grease was reviewed and referred to the thermometer subcommittee for study to prepare detailed specifications for suitable thermometers for this test of grease. The committee also discussed thermometers for use in distillation tests of solvents and diluents used in the manufacturing of paints and lacquers.

The flask in the tentative method of test for specific gravity and absorption of fine aggregate (C 128) specifies an accuracy of 0.1 ml. but should be 0.15 ml. in accordance with the National Bureau of Standards requirements for 500-ml. flask. The committee will recommend the use of a 250-ml. flask.

The committee expressed its opinion on pH study—that it merited complete study and offered its cooperation in drawing specifications for glassware required in this test.

The committee has in preparation three papers on testing of thermometers, hydrometers and graduated glassware.

Methods of Testing

The importance of the effect of speed in the testing of materials has for some time been recognized and the matter

has been studied by a section of Committee E-1 on Methods of Testing. In the past it has been common to judge the speed of testing by the rate of motion of the moving head of the testing machine. This method has come to be recognized as unsatisfactory since the relation of the speed of head of the testing machine to the rate of strain or rate of loading of the test specimen is a variable one, influenced by the slip in grips, elastic yield in bearing block and other parts of the machine, and other factors. The Section on Effect of Speed of Testing has accordingly favored as a proper basis for defining speed of testing of metallic materials for yield point determinations, the rate of stressing or the rate of deformation (strain).

The Section considered the recommendations of the Research Committee on the Yield Point of Structural Steel indicating that the yield point is of sufficient importance to the designing engineer to warrant increased accuracy in its determination and that present methods of procedure, particularly as regards the speed of testing, should be improved to attain that end.

A special committee has been appointed to prepare suggestions to guide the standing committees of the Society in their respective studies of speed problems. The Section will also sponsor a research investigation of a limited nature covering a study of speed effects on materials for immediate guidance in connection with the standardization work of Society committees. The committee also decided to consider the formulation of a comprehensive program to study the effect of speed of testing on the tensile properties of metals and alloys, both ferrous and non-ferrous.

Consideration is being given to the desirability of including in the standard methods of tension testing of metallic materials (E-8) recommended sizes of tension specimens smaller than the present standard specimens which it is customary to use when the material is of such size that it will not accommodate the prescribed sizes of test pieces.

The Section on Calibration of Testing Machines and Apparatus discussed at its meeting the calibration of extensometers and the work being done at the National Bureau of Standards on dynamic calibration of testing machines.

Foreign Standards Recently Issued

STANDARDS issued by a number of engineering and technical organizations in foreign countries are received by the Society as they are adopted. Since members of the Society may be interested in knowing that such standards are available they will be listed as received in the ASTM BULLETIN.

Recently the following standards have been issued by the British Standards Institution:

British Standard Specifications for:
- Metallic Resistance Materials for Electrical Purposes (No. 115 – 1938)
- Synthetic Resin (Phenolic) Moulding Materials and Mouldings (No. 771 – 1938)
- Ostwald-Folin Pipettes (No. 773 – 1938)
- Steel Flanged Joints for Hydraulic Pipe Lines for Pressures up to 4500 lb. per sq. in. (No. 778 – 1938)
- Wrought Iron Chain Slings and Rings, Links Alternative to Rings, Egg Links and Intermediate Links (No. 781 – 1938)

DEATH TAKES NO HOLIDAY

by ELMA ROBERTS WILSON

Death never takes a holiday:
He lurks on every street;
He crouches down each alley-way
His menace to repeat.

At every railroad crossing
He waits with patient grin;
Some fool will try to beat the train
And Death's the one who'll win.

Death stalks the little children
As they run out from school
And snatches them when drivers
Disobey the "Drive Slow" rule.

He tips the liquor bottle;
He drops the drowsy eye;
Chortles when drivers "hit 'er up"
For soon some one will die.

The long, straight, open stretches
Are where his harvest's best
(They are such tempting places
To put speed to the test.)

Death loves a dirty windshield,
A sudden, careless swerve;
He grows extremely chummy
When you park upon a curve.

He loves the glaring headlights,
Six fools in one coupe,
"Sixty" at the cross-roads
And trailers wide that sway.

He trots behind the casings,
Slides over worn brake bands;
When careless drivers turn their heads
He pounces on their hands.

Then rakes his gory winnings
From ditch, or pole, or tree
And chalks against pure carelessness
Another tragedy.

Yet there's a way to foil him,
And this the only way:
Obey the rules; be cautious
When driving, night or day.

Courtesy *Arizona Highways*

UNIQUE INTEREST COLUMN

Editor's Note.—Material for this column will be welcomed from any of the members and those who may have information in their files or know of sources where appropriate items can be obtained are urged to send them to Society Headquarters. It is planned that the items used will relate to the materials field, but they may not necessarily refer specifically to standardization or testing. The column will be essentially a members' column.

Historical and Zoological Note

Existence of a worm that ate up steel rails was reported in 1887 by a commission appointed by the German government to investigate a series of accidents that had occurred near Hagen. The Cologne Gazette quoted the commission's report as saying that a thin gray worm, two centimeters in length and the size of the prong of a silver fork in circumference, devoured 36 kilograms of rail in a fortnight. This voracious worm was reported to have softened the iron before eating by spraying it with a corrosive solution secreted by two glands in its head.

American metallurgists have never reported the existence of such a creature, which might indicate that steel-eating worms did not travel very far from their home land. —*"Steel Facts."*

I. A. T. M. Reviews

(Continued from page 12)

reviews of progress in the different countries. Just a few points of a more general interest might be mentioned.

The following data regarding the aluminum alloys—divided into wrought alloys (knetlegierungen) and cast alloys (gusslegierungen) may be given:

Discovery by Mach in 1898 of magnalium (3 to 30 per cent magnesium); by Wilm in 1908 of Duralumin (4.5 per cent copper, 0.5 per cent magnesium, 0.6 per cent managanese); by Rosenhain in 1917 of "Y" alloy (5 per cent copper, 2 per cent nickel, 1.5 per cent magnesium); in 1919 discovery of the cast alloy Silumin (13 per cent silicon); the paper of v. Zeerleder gave an excellent list of different alloys.

The progress now reported concerned: (1) Mechanical properties; (2) Chemical properties; (3) Electrical conductivity.

1. Duralumin, improved by increased magnesium and manganese contents, was still unsurpassed as a *structural alloy*; tensile strength 48 to 52 kg. per sq. mm. Still higher tensile strength was obtained in Rosenhain's alloy (containing 20 per cent zinc, 2.5 per cent copper), namely, 63 kg. per sq. mm.; not used now on account of its corrodibility and higher specific gravity. The cast alloy containing 4 to 10 per cent magnesium had attained great commercial importance in the United States on account of its high strength and corrosion resistance.

The elastic modulus of the light alloys was much lower (6000 to 7500 kg. per sq. mm.) than desired. No essential progress, however, was to be registered—and scarcely to be expected.

Light alloys could now be used in automatic screw machines; the addition of lead was reported as beneficial against clogging of tools.

Grain refinement, valuable for tensile properties, was attained by the addition of titanium and of cerium for cast alloys, as well as for wrought alloys.

For the determination of endurance limit (fatigue) the impact strength (resilience) could be used, as being easier to determine (Pizzuto).

Great benefit for the mechanical properties was derived from a rational heat treatment in general and an effective age-hardening in particular. Its theory, therefore, was widely interesting.

To improve the mechanical properties, increased use was made of fluxes on melting: thereby "pinholing" small gas blow holes) was avoided, although shrinkage was increased.

For mechanical properties at high temperatures, such as those occurring in internal combustion engines, much progress was reported. For good strength the alloy containing 4 per cent copper, 2 per cent nickel, and 1.5 per cent magnesium had proved very satisfactory (Rosenhain's Y-alloy; see Archbutt or v. Zeerleder).

A low dilatability, important for automobile pistons, was obtained by means of a high silicon content (12 to 14 per cent silicon; according to Dix and Jeffries).

2. Among *chemical properties*, resistance against corrosion was the most important. A fairly satisfactory resistivity against sea water was obtained by means of magnesium: 2 to 12 per cent (Stenzel) or 5 to 10 per cent (Archbutt). An addition of magnesium and silicon was said to be excellent, if composition and thermal treatment were carefully controlled (Dix and Jeffries). An addition of antimony was recommended (v. Zeerleder).

To combat corrosion, plating had come into considerable use; partly pure aluminum, partly a suitable aluminum alloy was used.

Much progress—though only scantily described in the present papers—had been made by means of a chemical or electrolytic surface treatment.*

3. In *electrical conductivity*, progress had been made in using, for overhead lines, aluminum containing some separate phase, Mg_2Si (see Archbutt). This seemed quite rational: if the tensile strength was increased by means of dissolved additions, the conductivity was lowered; therefore increasing strength by an intermixed compound which might have a good conductivity in itself, appeared much better.

(*c*) Regarding *magnesium alloys* two excellent papers were at hand:

Magnesium was isolated in 1808, but the manufacture of alloys was started only in 1900. Until recently, two groups of commercial alloys ("electron") were used:

1. Containing 3.5 to 10 per cent aluminum, with 0 to 3.5 per cent zinc; tensile strength up to, say, 32 kg. per sq. mm.

2. Containing about 2.5 per cent manganese; a tensile strength of 23 kg. per sq. mm. was reached. Even traces of manganese gave resistance to corrosion.

During the last two or three years certain new alloys had been developed (see Haughton paper):

3. With 8 per cent aluminum and 8 per cent cadmium a tensile strength up to 40 kg. per sq. mm. with good ductility was obtained.

4. With 8.5 per cent aluminum and 2.5 per cent silver a tensile strength up to 43 kg. per sq. mm. was obtained; this alloy, however, was useless at higher temperatures.

5. With 10 per cent cerium, 1.5 per cent cobalt and 1.5 per cent manganese, the alloy could be used at 200 to 300 C.; the tensile strength was 11.4 kg. per sq. mm. at 300 C.

A good list of the alloys mostly used in Germany was given (G. Siebel). The magnesium alloys were made in iron crucibles under a protecting layer of fluxes, permitting a temperature of 800 to 900 C. to be used. A high temperature resulted in a very fine-grain structure which was beneficial for the mechanical properties. On casting, sulfur was powdered on, thus minimizing oxidation. The cast alloys were considerably improved by mechanical treatment (at 300 to 400 C.). For this the anisotropy of the hexagonal magnesium required certain precautions.

The great interest of the aircraft and automobile industries in magnesium alloys was mainly due to the saving of energy attained by giving reciprocating parts a small mass. Another valuable property was, besides their high heat conductivity, that of the equalization of the temperature of the moving part.

The low fatigue properties in magnesium alloys had lately been remarkably improved and the low modulus of elasticity—undesirable in itself—was taken advantage of.

As for *chemical properties*, the corrodibility was not so serious a difficulty as was thought; actually, good methods of protection had been developed (see Haughton). Apparently the atmospheric corrosion of an unprotected surface of magnesium alloy could be quite insignificant; this, however, was because the MgO formed was dissolved by rain water.

Workability and Wear

WORKABILITY

The President, resuming critically the most prominent features of the Reports and Discussions, wrote as follows: As had already been pointed out, the plastic deformation of metals—forging—had been known and used since remotest times. The actual knowledge of this procedure, however, had been very restricted up to recent years. Hence, it was of great value to have the main points of this process elucidated in a clear and accurate manner (E. Siebel).

*Reference may be made, on this and other points, to the second edition of A. von Zeerleder, "*Technologie des Aluminiums und seiner Leichtlegierungen*," Leipzig, 1935, and also to H. Bürgel, "*Deutsche Austausch-Werkstoffe*," Berlin, 1937, p. 4.

Regarding the *cutting of metals*, an interesting observation was made by E. K. Henriksen, implying that in a planed surface of steel certain tension stresses occurred, causing the machined specimen to become concave. For cast iron a (smaller) compression stress was obtained. The phenomenon was obviously rather complicated; reference could be made to the textbook by G. Schmaltz, "Technische Oberflächenkunde," Berlin, 1936, p. 145.

A very careful review of the present state of knowledge, with special reference to German researches, was given, with a comprehensive bibliography, by Professor Opitz, referring to the extensive work of his predecessor, Professor Wallichs. A point of interest was the result obtained on machining light alloys, which caused a special type of wear.

An interesting review of tests made in order to find the factors which determine cutting power, so as partly to dispense with actual cutting tests, was given by Prof. Dempster Smith. An interesting result was that the efficiency of an 18 per cent tungsten super-high-speed steel was greatly increased by the addition of 12 per cent cobalt.

In the following discussion, among other points, mention was made of an experiment at the Hungarian State Iron and Steel Works, which implied that a high-speed steel, containing 12 per cent copper, showed an optimum speed, at which the abrasion of the edge was a minimum (Vietorisz). As a testing method the steel was used in the form of a carpenter's plane tool, the shavings of a uniform, hard wood obtained with it being weighed.

The much-debated question whether "hard" or "soft" cast iron caused the strongest abrasion of the tool was elucidated in an interesting way by Meyersberg showing that a harder cast iron actually gave the higher abrasion. The opposite view which was frequently heard was due to the fact that an ordinary "soft" cast iron frequently contained hard inclusions.

Reference was made, by Professor Korber, to a new method for the study of the deformation and depth of a machined surface layer. This method consisted in measuring the blurring of X-ray lines, obtained after a successive removal of metal by etching.

WEAR

As for wear in general, several important contributions were given. That wear presented a great similarity to corrosion was well brought out in the paper by F. Le Chatelier (containing a good list of references). Both phenomena were actually very complicated. Just as it was impossible to develop a universal method for corrosion testing, so it must be impossible to find a universal method for wear testing. In both cases substance was removed from the surface of an object: in wear, essentially by varying mechanical forces; in corrosion, essentially by varying chemical forces. The testing method must adapt itself to the forces at hand.

These points of view were further developed by H. Meyer, who gave examples showing that the method must be chosen according to the analysis of the abrading process. Abrasion resistance was *not* a specific property of a material.

That by friction or abrasion extremely high temperatures could be reached had been long known. It was, however, unexpected to learn from the important contribution of Bowden and Hughes that in ordinary bimetallic sliding friction very high local temperatures could be reached. The excellence and reliability of the experimental method used was very striking.

The complicated character of wear was further well borne out by the paper by H. E. Smith: "The fundamental principles of scientific abrasion testing have yet to be discovered." An interesting fact was that "in general a high atmospheric humidity was associated with a low rate of wear," and also that the elimination of debris by an air blast was found to lower wear.

BEILBY LAYER

The discussion largely centered around the problem of the Beilby hypothesis of an "amorphous" ("vitreous") surface layer. The observations of Bowden and Hughes had been considered to give a strong support to the occurrence of a "liquid" layer as seemingly admitted by Beilby. At least it was pointed out (Desch) that Beilby admitted an actual melting to take place on polishing the surface. This interpretation seemed, to the present writer, not quite to do justice to the perspicuous conclusion of Beilby, namely that a *surface flow*, which, of course, could take place even at a low temperature, was formed on polishing. Now, if this surface layer actually should be liquid, i.e. at a very high temperature, this would require that, on account of the high temperature, its structure should necessarily be coarse grained; on the other hand, if this surface layer had been formed, say atom for atom, at low temperature, it might more easily preserve a very fine-grained, almost amorphous character, which obviously was the essence of Beilby's theory.

An actual liquefaction at the surface, far from giving rise to a Beilby amorphous layer—as was clearly pointed out in the discussion (Hatfield)—would cause the layer considered to be comparatively coarse grained.

The demonstrated liquefaction by friction recalled a hypothesis due to Johnston and Adams, which implied that any deformation of a metal signified a partial melting. In this, in the same way as in the old regelation theory of ice, any deformation was assumed to be due to some melting, a view now generally rejected. The fact that a certain parallelism existed between the deformability and liquefaction of metals by no means implied that the former was due to the latter; it only meant that they depended on some common factor.

Thus, in the writer's opinion, the extremely valuable work of Bowden and Hughes must not be interpreted as giving strong evidence in favor of the existence of a "vitreous" layer on a polished metal, or for the newer regeleation theory of metallic deformation.

If, at very high polishing speeds, melting really occurred on the surface of a specimen, this by no means justified the general conclusion that melting always occurred on polishing.

As was seen earlier at the Congress, one supposed direct proof of the existence of a really amorphous layer in a polished surface could not claim validity, since it had been found that the amorphous layer observed by electron diffraction simply consisted of condensed gases (Kirchner).

If, thus, no direct proof of the amorphous layer could still be said to exist, it should be kept in mind that on polishing, especially for soft metals and in using a polisher of steel or haematite ("brunissoir"), also in any cold-working of the surface, a fine-grained surface layer must be formed which more or less approached the amorphous state.

An interesting progress in the knowledge of such layers was indicated in connection with metal cutting (Professor Körber).

The observation that a thin layer of zinc diffused rapidly at room temperature into a polished copper surface, while it scarcely diffused at all after removal, by etching, of the polished layer (Finch), was very interesting indeed, but it did not permit of a decision whether it was merely a fine-grained layer or an amorphous layer which was present.

The interesting observation mentioned in the discussion (Skapski), namely, that a copper surface when polished under benzene and subsequently protected from oxygen, gave the electron diffraction pattern of crystallized copper, proved that the polished surface layer, at least in some cases, was far from being amorphous.

WEAR IN SPECIAL CASES

Regarding *wear in special cases* several interesting and practically important papers and contributions were provided.

An experience important from a practical point of view was described in the report by Pohl: driven wheels of locomotives on the Austrian railways suffer wear by exfoliation (Abblätterung) much more than the driving wheels. This wear was not found to be due to defects in the material; the trouble was largely overcome by using tires of harder steel, containing manganese or manganese plus silicon.

Interesting experiments on the reduction of wear were described by Saito, implying the substitution of a lubricant by a soft solid substance which smoothed out the gliding surfaces. In view of the old way of using graphite as a solid lubricant, it seemed quite appropriate to try to find other suitable substances.

As for the wear resistance of cast iron, it had been found by Suzuki that hardness and tensile strength exerted but little influence; the chemical composition, on the contrary, had an influence: phosphorous increased the resistance most, then came combined carbon; silicon had a variable influence. The existence of a "critical" pressure, characteristic of wear, was discussed.

It had been found by Rosenberg that Amsler wear tests on hardened and tempered steels, when made in air, gave a low rate of abrasion; when made in hydrogen or nitrogen, the abrasion was likewise weak if the steel was hard (*i.e.* tempered at a low temperature) but very strong if the steel was soft (i.e. tempered at a high temperature). Thus, an oxide layer afforded protection against wear.

A result which no doubt was very important was described by Ros and Eichinger—that abrasion, as obtained in an Amsler machine between two cylindrical steel disks, was greatly dependent on the external medium. If water was present, the abrasion was found to be much greater, giving more peeling off than when air was the external medium. The authors explained this observation on the assumption that water, adhering to the surfaces of the disks, when approaching their contact zone, received a high hydrostatic pressure which penetrated into fissures and finally caused particles to separate. This phenomenon might exert a noticeable influence on the wear of tires discussed by Pohl.

In his written comments to this observation, Pohl admits the accuracy of this experiment, and its explanation, but he says that the wedge action referred to cannot make itself felt between tire and rail, due to too poor a contact. In any case, only the first pair of wheels could possibly be affected as, according to Pohl, these would sweep any rainwater away from the following wheels.

Thus, the problem appeared to be rather obscure. In view of its theoretical interest and practical importance, the present writer desired to attempt to expose the conclusions which could be drawn from the facts described.

Concrete and Reinforced Concrete

PROF. E. SUENSON (Denmark), President of Group B, in reviewing the papers on concrete and reinforced concrete, said that in the matter of laboratory technique in testing the strength of plastic mortar, two opinions were represented, the one advocating the use of sand with a greater proportion of ground silica in order to increase the water-cement ratio, and the other favoring a more natural sand and a lower water-cement ratio, and possibly, the use of vibration.

The properties of aluminous cement were discussed, and in particular the fall in strength at a temperature of about 40 C. was mentioned from several sources. An essential point was whether that decrease in strength was the only result of the high temperature, or whether more serious shortcomings might develop subsequently. There was no reason to assume that the latter was the case. With regard to sea-water cement, the advantages of pozzolanic cement and especially Ferrari cement had been emphasized. As to the mortar to be used for testing, it seemed that a plastic consistency gave more reliable results than a dry one. With regard to integral waterproofing, it had been demonstrated that it was not essential to use any other compound than cement for making waterproof cement, but in certain cases special compounds might prove useful.

As to shrinkage of concrete, the chemical composition of the cement and the curves of contraction of the system water *plus* cement were shown to be indicative of the behavior. It was demonstrated that the petrographic nature of the aggregates had an outstanding influence on shrinkage. The essential factor for cracking was not the absolute extent of shrinkage, but the proportion between the tension arising through shrinkage and the tensile strength of the concrete. Massive structures showed comparatively less shrinkage than thin ones. Wet curing extended over a long period seemed to reduce shrinkage.

Very interesting tests were reported with regard to creep of concrete under load. Some of them seemed to confirm that it was possible to calculate the influence of creep on the steel stresses in reinforced concrete, and, furthermore, that creep did not reduce seriously the strength of most reinforced concrete structures. Regarding vibrated concrete, many different features of the process had been discussed. The common properties of concrete pipes had been discussed, and the new types of spun concrete pipes described. It was stated that the use of high yield-point steel in reinforced concrete had given full satisfaction. Many other interesting topics had been discussed, among which he would mention merely the research concerning the influence of pressure on the setting of cement, the influence of temperature on the strength of concrete, and the discrepancy between the normal formula and the resistance against torsion.

Relation of Laboratory Tests and Service

VICE-PRESIDENT DR. M. ROS (Switzerland) summarized the points raised in discussion and said that the results of tests and the study of materials in the laboratory yielded characteristic data for the physico-chemical and mechanical properties, *i.e.* the resistance and deformation of a material. These data, based on experience, enabled the suitability of a material for a specific application to be determined. The testing of materials in the laboratory, the control exercised in the field and factory, experiments on completed constructions and the experience gained afterward formed an inseparable whole. The different materials varied greatly in their structural constitution and mechanism of deformation, and consequently there was no single theory that could be generally applied with regard to permanent deformations, rupture or fatigue. Therefore each group of materials required a special theory, by which their safety in use could be determined. Only by using scientific methods and their results, assisted by experience, the sole source of truth, could technical problems be solved with success.

The progress made in applied physics and chemistry is of very great importance to the whole subject of the testing of materials. If the study and testing of materials is to result in the development of methods of investigation, to contribute to scientific knowledge, and provide solutions of technical problems, the following observations are required:

(1) Examination with the microscope under various lightings and with X and γ rays, in relation to the mechanism of deformation.

(2) Tests to ascertain the beginning of fatigue fracture.

(3) The study of the transformations that occurred in metals in conjunction with fatigue tests at high temperatures.

(4) The study of changes in the properties of materials at low temperatures.

(5) Special topochemical problems—local reactions—studied in conjunction with microscopic and X-ray observations.

NEW MEMBERS TO MARCH 7, 1938

The following 82 members were elected from January 7 to March 7, 1938, making the total membership 4116:

Company Members (14)

AMERICAN BRAKE SHOE AND FOUNDRY CO., Earnshaw Cook, Metallurgist, Metallurgical Dept., Mahwah, N. J.

AMERICAN OPTICAL CO., H. R. Moulton, Assistant Director of Research, Mechanic St., Southbridge, Mass.

BELL & HOWELL CO., G. E. Stryker, Metallurgist, 4045 N. Rockwell St., Chicago, Ill.

CARTER COAL CO., H. C. Ray, Combustion Engineer, 230 Park Ave., New York City.

DOLPH CO., JOHN C., G. C. Borthig, Vice-President, 168 Emmett St., Newark, N. J.

DOMINION WHEEL AND FOUNDRIES, LTD., T. Clough, Works Manager, 171 Eastern Ave., Toronto, Ont., Canada.

FISKE BRICK AND GRANULE CO., C. L. Colbert, Consultant, 137 Newbury St., Boston, Mass.

HOLWAY & NEUFFER, CONSULTING ENGINEERS, W. R. Holway, 302 E. Eighteenth St., Tulsa, Okla.

MARYLAND CASUALTY CO., A. G. L. Barkow, Metallurgical Engineer, Baltimore, Md.

MORACRETE, LTD., T. J. Moran, Managing Director, Crumlin Road, Dublin, Ireland.

MT. VERNON DIE CASTING CORP., Gustav Nyselius, President, 118 Pearl St., Mt. Vernon, N. Y.

RADIUM CHEMICAL CO., INC., G. T. Taylor, Sales Manager, 1 E. Forty-second St., New York City.

RICHFIELD OIL CORP., William Murray, Vinvale Refinery, Bell, Calif.

UNION ASBESTOS AND RUBBER CO., R. E. Cryor, Research Engineer, 1821 S. Fifty-fourth Ave., Cicero, Ill.

Individual and Other Members (59)

ALLISON, JAMES, Factory Manager, The Billings & Spencer Co., 1 Laurel St., Hartford, Conn.

ASSOCIATES FOR GOVERNMENT SERVICE, INC., 1860 Broadway, New York City.

BARSOTTI, C., Chief Chemist, Cia. Nacional de Cimento Portland, Rio de Janeiro, Brazil.

BEDELL, H. L., Chief Chemist, Socony-Vacuum Oil Co., Inc., White Eagle Division, Kansas City, Mo. For mail: Box 546, Augusta, Kans.

BILLINGSLEY, GEORGE, Chief Chemist, Cia. Argentina de Cemento Portland, Parana, Argentina.

BOLTON, E. J., Director, Thomas Bolton & Sons, Ltd., Mersey Copper Works, Widnes, Lancashire, England.

BOTTOMLEY, HAROLD, Chief Chemist, Cosden Petroleum Corp., Big Spring, Tex.

BOWDEN, J. J., Chief Metallurgist, Republic Steel Corp., 3100 E. Forty-fifth St., Cleveland, Ohio.

CATTON, M. D., Highway Engineer, Portland Cement Assn., Chicago, Ill. For mail: 7341 N. Seeley Ave., Chicago, Ill.

CHEQUER, HENRY, JR., Assistant Manager, Standardization Bureau, Metropolitan Life Insurance Co., New York City. For mail: 38 Trinity Place, New Rochelle, N. Y.

CHIESA, GIOVANNI, Director, Fiat Stabilimento Grandi Motori, Casella Postale 500, Torino, Italy.

CULVER, S. G., Chief Engineer, Key System, 2129 Grove St., Oakland, Calif.

DALTON, J. N., Chief Chemist, Pacific Mills, Worsted Division, Canal St., Lawrence, Mass.

DIECKMANN, G. P., Chemical Engineer, Northwestern States Portland Cement Co., 1103 N. Jefferson, Mason City, Iowa.

DUNCAN, N. B., National Tube Co., McKeesport, Pa.

ERNST, G. C., Assistant Professor of Civil Engineering, University of Maryland, College Park, Md. For mail: 220 College Ave., College Park, Md.

ESCANDON, M. F., Research Chemical Engineer, Laboratorio Central, Secretaria de la Economia Nacional, Mexico, D. F., Mexico. For mail: Praga 9, Mexico, D. F., Mexico.

EVANS, H. L., Chief Alloy Investigator, Research Dept., National Smelting Co., Ltd., Avonmouth, England.

FARNSWORTH, T. W., Technical Adviser, Revere Copper and Brass, Incorporated, Taunton-New Bedford Division, 24 N. Front St., Bedford, Mass.

FREYERMUTH, J. R., Materials Engineer, Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. South, Minneapolis, Minn.

GRABE, C. G., Chief Engineer, National Valve and Manufacturing Co., 3101 Liberty Ave., Pittsburgh, Pa.

HARING, W. S., Vice-President in Charge of Sales, Alan Wood Steel Co., Conshohocken, Pa.

HICKS, VICTOR, Industrial X-ray Engineer, Westinghouse X-ray Co., 21-16 Forty-third Ave., Long Island City, N. Y.

HORGER, O. J., Research Engineer, Timken Roller Bearing Co., Canton, Ohio.

HOVEY, W. F., Engineer, Sanderson & Porter, 52 William St., New York City.

JACKSON, ALAN, Chemist, Alpha Cement Limited, Thames House, Millbank, London, S. W. 1, England.

JACOBSEN, A. S., Technical Director, Cia. Cirrus S. A., Rua da Alfandega 28-1°and., Rio de Janeiro, Brazil.

JEFFERSON COUNTY, ENGINEERING DEPT., H. H. Hendon, Chief Engineer, 216 Court House, Birmingham, Ala.

KREHBIEL, A. R., Town Engineer, Town of Tonawanda, N. Y., 20 Municipal Building, Kenmore, N. Y.

LETELIER, MIGUEL, Professor of Strength of Materials and Chief of Laboratory for Testing Materials, Universidad Católica de Chile, Santiago, Chile. For mail: Cienfuegos 55, Santiago, Chile.

LOWRY, R. D., Experimental Engineer, Dow Chemical Co., Midland, Mich. For mail: 1410 Crane Court, Midland, Mich.

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MCKAY, C. R., Richfield Oil Corp., Box 787, Wilmington, Calif.

MCNUTT, C. E., Superintendent, McNutt Oil and Refining Co., Box 1161, El Paso, Tex.

MORGAN, C. P., Chief Chemist, Vulcanized Rubber Co., 480 Harper Ave., Morrisville, Pa.

NORTH CAROLINA STATE HIGHWAY AND PUBLIC WORKS COMMISSION, C. E. Proudley, Engineer of Materials and Tests, Raleigh, N. C.

OSMIN, BASIL, Welding Engineer, Maryland Casualty Co., Baltimore, Md.

PATTERSON, RUSSELL G., President, Russell G. Patterson and Associates, Inc., Consulting Engineers, 708 E. Gregory St., Pensacola, Fla.

PAVITT, H. A., Research Metallurgist, Simonds Saw and Steel Co., Lockport, N. Y.

PENNSYLVANIA STATE COLLEGE, THE, G. H. Ebert, Superintendent, Grounds and Buildings, State College, Pa.

REICHENBACH, A. T., Chief Metallurgist, Edgar Thomson Works, Carnegie-Illinois Steel Corp., Braddock, Pa.

RICE, G. P., Consulting Engineer, Baronne Building, New Orleans, La.

ROBERTS, CHARLES, Pittsburgh Representative, H. C. Nutting Co., 5700 Penn Ave., Pittsburgh, Pa.

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SANG, HENRY, Test Engineer, Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pa. For mail: Box 1, Moylan, Pa.

SAXL, I. J., Consulting Chemist and Physicist, Industrial Trust Building, Providence, R. I.

SEEBER, R. R., Professor of Mechanical Engineering, Michigan College of Mining and Technology, Houghton, Mich.

SEEMANN, H. E., Physicist, Eastman Kodak Co., Kodak Park Research Laboratories, Rochester, N. Y.

SHARF, J. M., Technical Director, American Bottlers of Carbonated Beverages, 224 Southern Building, Washington, D. C.

SMYTHE, C. M., Gulf Division Manager, E. W. Saybolt and Co., 714 Petroleum Building, Houston, Tex.

THOMASSEN, LARS, Assistant Professor Department of Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor, Mich.

UNIVERSITY OF OKLAHOMA, COLLEGE OF ENGINEERING LIBRARY, Norman, Okla.

VIRGINIA DEPARTMENT OF AGRICULTURE, DIVISION OF CHEMISTRY, W. Catesby Jones, Chief Chemist, 1121 State Office Building, Richmond, Va.

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WILLIAMS, R. S., Professor of Physical Metallurgy, In Charge of Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

WORTHINGTON, H. D., Manager of Sales, American Steel and Wire Co., 417 Grand Ave., Kansas City, Mo.

Junior Members (9)

CRAWFORD, R. T., Textile Engineer, Tennessee Eastman Corp., Kingsport, Tenn. For mail: 1227 Watauga St., Kingsport, Tenn.

ELLIS, W. P., JR., Chemist, E. I. du Pont de Nemours and Co., Inc., Philadelphia, Pa. For mail: 430 S. Fortieth St., Philadelphia, Pa.

ENDLER, A. S., Junior Mechanical Engineer, National Bureau of Standards, Industrial Building, Washington, D. C.

Erickson, L. F., Assistant Testing Engineer, Department of Public Works, Bureau of Highways, Materials Laboratory, Moscow, Idaho. For mail: Box 403, University Station, Moscow, Idaho.

King, J. P., Chief Inspector, Lincoln Electric Co., Cleveland, Ohio. For mail: 3155 Berkshire Road, Cleveland Heights, Ohio.

Kraus, P. B., Junior Industrial Engineer, E. I. du Pont de Nemours and Co., Inc., Curtis Bay, Md. For mail: 411 Pontiac Ave., Baltimore, Md.

Patterson, D. R., Jr., Research Chemist, Kanotex Refining Co., Arkansas City, Kans.

Seligman, Sylvan, Assistant Sales Manager, Pioneer Asphalt Co., 435 N. Michigan Ave., Chicago, Ill.

Stampfle, R. B., Apprentice, Bethlehem Steel Co., Inc., Cambria Plant, Johnstown, Pa. For mail: 349 Stonycreek St., Johnstown, Pa.

PERSONALS

. . . News items concerning the activities of our members will be welcomed for inclusion in this column.

M. H. Gorbin, formerly Research Director, The Arco Co., Cleveland, Ohio, is now connected with the Standard Varnish Co., Staten Island, N. Y.

F. D. Klein, Jr., is Research Chemist, Devoe & Raynolds Corp., St. Matthews, Ky. He was Technical Director, Berry Brothers, Inc., Detroit, Mich.

H. N. Bassett, who was Chief Chemist, Egyptian State Railways, Cairo, Egypt, has left Egypt to establish and take charge of a central laboratory for the Buenos Aires and Pacific Railway and several other British-owned railways in the Argentine.

R. R. Litehiser is now Director of Engineering, New York State Crushed Stone Assn., Albany, N. Y. He was formerly Chief Engineer, Bureau of Tests, Ohio State Highway Testing Laboratory.

L. H. Seabright, formerly Graduate Student, Ohio State University, Columbus, Ohio, is now connected with the Westinghouse Electric and Manufacturing Co. as Chemical Engineer, Feeder Engineering Dept., in Wilkinsburg, Pa.

Kalman Steiner, who was Chief Engineer, Consumers Petroleum Co., Chicago, Ill., is now Superintendent, Mid-West Heat Service Co., Chicago, Ill.

H. J. Baker is Engineer, Steel Inspection, The Port of New York Authority, New York City. He was Chief Inspecting Engineer, Golden Gate Bridge and Highway District, New York City.

M. N. Egoroff, formerly Chief, Technical Research-Special Adviser, Resettlement Administration, is now Senior Engineer, Bureau of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

Hyman Bornstein, Director of Laboratories, Deere and Co., was recently nominated to serve three years as a Director of the American Foundrymen's Association.

F. M. Farmer, Vice-President and Chief Engineer, Electrical Testing Laboratories, New York City, was recently nominated for Vice-President, New York City District, American Institute of Electrical Engineers.

J. L. Keenan, who served for eight years as General Manager, Tata Iron and Steel Co., Ltd., Jamshedpur, India, and who was connected with the company for twenty-five years, has retired. At a public meeting of the citizens of Jamshedpur a silver model of a blast furnace was presented to him.

At a meeting of the Compressed Gas Manufacturers Assn., held in New York City recently, J. J. Crowe, Manager, Apparatus Research and Development Dept., Air Reduction Sales Co., Jersey City, was elected President.

D. E. Douty, President, United States Testing Co., Inc., completed twenty-five years of service on January 1 as head of the company's testing laboratories.

L. A. Graybill, Chief Technologist, Bibb Manufacturing Co., Macon, Ga., was recently transferred to the Columbus, Ga., mill, where he will be in charge of the quality and production of the tire fabric division.

At the recent meeting of the American Institute of Mining and Metallurgical Engineers held in New York City, the following A.S.T.M. members were elected to office:

P. D. Merica, Vice-President and Director, The International Nickel Co., Inc., New York City, *Vice-President;* J. T. MacKenzie, Chief Chemist, American Cast Iron Pipe Co., Birmingham, Ala., Chairman of the Iron and Steel Division; H. W. Graham, General Metallurgist, Jones & Laughlin Steel Corp., Pittsburgh, Pa., Vice Chairman of the Iron and Steel Division; R. F. Mehl, Director, Metals Research Laboratory, and Head, Department of Metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa., Chairman of the Institute of Metals Division; R. H. Leach, Manager of Research and Development, Handy & Harman, Bridgeport, Conn., Vice Chairman of the Institute of Metals Division; and D. L. Colwell, Sales Manager, Stewart Die Casting Corp., Chicago, Ill., as a member of the Executive Committee. J. H. Nead, Chief Metallurgist, Inland Steel Co., East Chicago, Ind., was a co-recipient of the Robert Woolston Hunt award established in 1920 to recognize the best institute paper during the year, on iron and steel. This year's award was made for the authors' paper on the structure of rimmed steel ingots, presented at the 1937 annual meeting.

A. R. Curtis, formerly Junior Chemist, Massachusetts Department of Public Works, Boston, Mass., is now Sales Engineer, Colonial Beacon Oil Co., Inc., Concord, N. H.

H. J. Kicherer is now connected with International Harvester Co., Chicago, Ill. He was formerly Works Manager, American Hoist and Derrick Co., St. Paul, Minn.

C. S. Altemus, who was Chemist, Raw Material Control, Standard Varnish Works, Elm Park, Staten Island, N. Y., is now Lacquer Chemist, Titanine, Inc., Union City, N. J.

G. B. Heckel, Editor-Publisher, *Drugs, Oils and Paints,* was the guest of honor at a testimonial dinner commemorating his eightieth birthday and his 50 years with the paint, varnish and chemical industries given by 250 of his friends at The Waldorf-Astoria, New York City, on March 13.

B. L. McNulty, President, Marblehead Lime Co., Chicago, Ill., was recently elected to the Board of Trustees of Armour Institute of Technology.

T. S. Fuller, formerly Metallurgist, Research Laboratory, General Electric Co., Schenectady, N. Y., has been appointed Engineer of Materials.

Calendar of Society Meetings

(Arranged in Chronological Order)

American Society of Mechanical Engineers—Spring Meeting, March 23-25, Los Angeles, Calif.; Semi-Annual Meeting, June 20-24, St. Louis, Mo.

American Ceramic Society—Fortieth Annual Meeting, March 27-April 2, New Orleans, La.

American Chemical Society — Semi-Annual Meeting, April 18-21, Dallas, Texas.

American Society of Civil Engineers—Spring Meeting, April 20-22, Jacksonville, Fla.

American Water Works Association—Annual Convention, April 24-28, New Orleans, La.

American Foundrymen's Association—May 14-19, Cleveland, Ohio.

Society of Automotive Engineers—June 12-17, The Greenbrier, White Sulphur Springs, West Va.

American Institute of Electrical Engineers—Summer Convention, June 20-24, Washington, D. C.

American Society for Testing Materials—Annual Meeting, June 27-July 1, Chalfonte-Haddon Hall, Atlantic City, N. J.

American Association for the Advancement of Science—Summer Meeting, June, Ottawa, Canada.

NECROLOGY

We announce with regret the death of the following members and representatives:

B. M. Brigman, Dean, Speed Scientific School, University of Louisville, Louisville, Ky. Dean Brigman represented the University in its membership for several years.

Herbert R. Browne, Chemical Director, Michigan Alkali Co., Wyandotte, Mich. Member since 1930.

H. M. Bunker, President, H. M. Bunker and Co., Inc., New York City. Member since 1931. Mr. Bunker was a member of Committee D-13 on Textile Materials and its Subcommittee B-4 on Bleaching, Dyeing and Finishing.

Leslie E. Howard, Director of Research (Retired), Simonds Saw and Steel Co., Lockport, N. Y. Member since 1903. Mr. Howard held membership on Committee A-6 on Magnetic Properties, the A-6 Advisory Subcommittee and Subcommittee III on Direct Current Test Methods; also Committee A-9 on Ferro-Alloys and its Subcommittee I on Specifications.

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